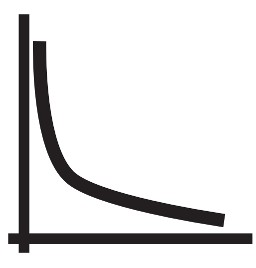
F-PRO 4000

Distribution Protection & Management Relay



User Manual

Version 1.0 Rev 0

Preface

Information in this document is subject to change without notice.

This manual is part of a complete set of product documentation that includes detailed drawings and operation. Users should evaluate the information in the context of the complete set of product documentation and their particular applications. ERLPhase assumes no liability for any incidental, indirect or consequential damages arising from the use of this documentation.

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Using This Guide

This User Manual describes the installation and operation of the F-PRO Distribution Protection & Management Relay. It is intended to support the first time user and clarify the details of the equipment.

The manual uses a number of conventions to denote special information:

Example	Describes
Start>Settings>Control Panel	Choose the Control Panel submenu in the Settings submenu on the Start menu.
Right-click	Click the right mouse button.
Recordings	Menu items and tabs are shown in italics.
service	User input or keystrokes are shown in bold.
Text boxes similar to this one	Relate important notes and information.
..	Indicates more screens.
▶	Indicates further drop-down menu, click to display list.
	Indicates a warning.

Table of Contents

Acronyms

ASG - Active Setting Group

CID - file extension (.CID) for Configured IED Description

CT - Current Transformer

DCE - Data Communication Equipment

DIB - Digital Input Board

DIGIO - Digital Input/Output Board

DMDS - Dead Main Dead Sync

DMLS - Dead Main Live Sync

DNP- Distributed Network Protocol

DSP - Digital signal processor

DTE - Data Terminal Equipment

FOCB -F-PRO Output Contact Board

GFPCB - Graphics Front Panel Comm Board

GFPDB - Graphics Front Panel Display Board

GPS - Global Positioning System

HMI - Human Machine Interface

ICD - file extension (.ICD) for IED Capability Description

IEC - International Electrotechnical Commission

IED - Intelligent Electronic Device

IP - Internet Protocol (IP) address

IRIG-B - Inter-range instrumentation group time codes

LED - Light-emitting Diode

LHS - Left Hand Side

LMDS - Live Main Dead Sync

LOP - Loss of Potential

MPB - Main Processor Board

MPC - Micro Processor

PLC - Programmable Logic Controller

PT-Potential Transformer

RAIB -Relay AC Analog Input Board

RASB -Relay AC Analog Sensor Boards

RHS - Right Hand Side

RPCB - Rear Panel Comm Board

RTOS - Real Time Operating System

RTU - Remote Terminal Unit

SCADA - Supervisory Control And Data Acquisition

SG - Setting Group

TCP- Transmission Control Protocol

THD- Total Harmonic Distortion

TUI - Terminal User Interface

UDP- User Data gram Protocol

UI - User Interface

VI - Virtual Input

Version Compatibility

This chart indicates the versions of Offliner Settings and ICD files which are compatible with different versions of F-PRO firmware.

RecordBase View and Offliner Settings are backward compatible with all earlier versions of records and setting files. Use RecordBase View to view records produced by any version of F-PRO firmware and Offliner Settings can create and edit older setting file versions.

Minor releases (designated with a letter suffix - e.g. v3.1a) maintain the same compatibility as their base version. For example. F-PRO firmware v3.1c and Offliner Settings v3.1a are compatible.

F-PRO 4000 Firmware/Software Compatibility Guide			
F-PRO Firmware	**Setting Version**	**Compatible Offliner Settings**	**ICD File Version**
v1.0	401	v1.0 or greater	v1.0

Please contact ERLPhase Customer Service for complete Revision History.

PC System Requirements and Software Installation

Hardware

The minimum hardware requirements are:

- 1 GHz processor
- 2 GB RAM
- 20 GB available hard disk space
- USB port
- Serial communication port

Operating System

The following software must be installed and functional prior to installing the applications:

- Microsoft Windows XP Professional Service Pack 3 or
- Microsoft Windows 7 Professional Service Pack 1 32-bit or 64-bit

Relay Control Panel requires a minimum of Windows XP SP3 (it will not work on earlier versions of Windows).

Software Installation

The CD-ROM contains software and the User Manual for the F-PRO Distribution Protection & Management Relay.

Software is installed directly from the CD-ROM to a Windows PC. Alternatively, create installation diskettes to install software on computers without a CD-ROM drive.

The CD-ROM contains the following:

- F-PRO Offliner Settings: Offliner settings program for the relay
- F-PRO Firmware: Firmware and installation instructions
- F-PRO User Manual: F-PRO manual in PDF format
- F-PRO Function Logic Diagram: diagram in PDF format
- Relay Control Panel: software
- Relay Control Panel User Manual: manual in PDF format
- USB Driver

To Install Software on the Computer

Insert the CD-ROM in the drive. The CD-ROM should open automatically. If the CD-ROM does not open automatically, go to Windows Explorer and find the CD-ROM (usually on D drive). Open the ERLPhase.exe file to launch the CD-ROM.

To install the software on the computer, click the desired item on the screen. The installation program launches automatically. Installation may take a few minutes to start.

To view the F-PRO User Manual the user must have Adobe Acrobat on the computer. If a copy is needed, download a copy at www.adobe.com.

Anti-virus/Anti-spyware Software

If an anti-virus/anti-spyware software on your local system identifies any of the ERLPhase applications as a “potential threat”, it will be necessary to configure your anti-virus/anti-software to classify it as “safe” for its proper operation. Please consult the appropriate anti-virus/anti-spyware software documentation to determine the relevant procedure.

1 Overview

1.1 Introduction

The F-PRO 4000 is a microprocessor-based relay providing comprehensive directional overcurrent protection, reclosing, metering, breaker monitoring and recording functions suitable for medium and low voltage lines.

F-PRO has two working modes—online and offline. In the online mode you can use communication software package Relay Control Panel. In online mode you can:

- change and review relay settings
- view event and metering information
- initiate and retrieve recordings, and retrieve settings

In offline mode you can use Offliner Settings and RecordBase View software to:

- create and review relay settings
- analyze fault waveforms
- store records

In addition to the protection functions F-PRO provides fault recording (96 sample/cycle) to facilitate analysis of the power system after a disturbance has taken place. The triggers for fault recording are established by programming the output matrix and allowing any internal relay function or any external input to initiate recording.

The primary protection provided is overcurrent based. A library for these overcurrent functions provides commonly used IEEE and IEC inverse curves. Because the curves are equation-driven, you can choose to enter an equation parameter directly, creating other overcurrent shapes as needed. All overcurrent functions are provided with directional control, if required, using the ERLPhase method of positive sequence control.

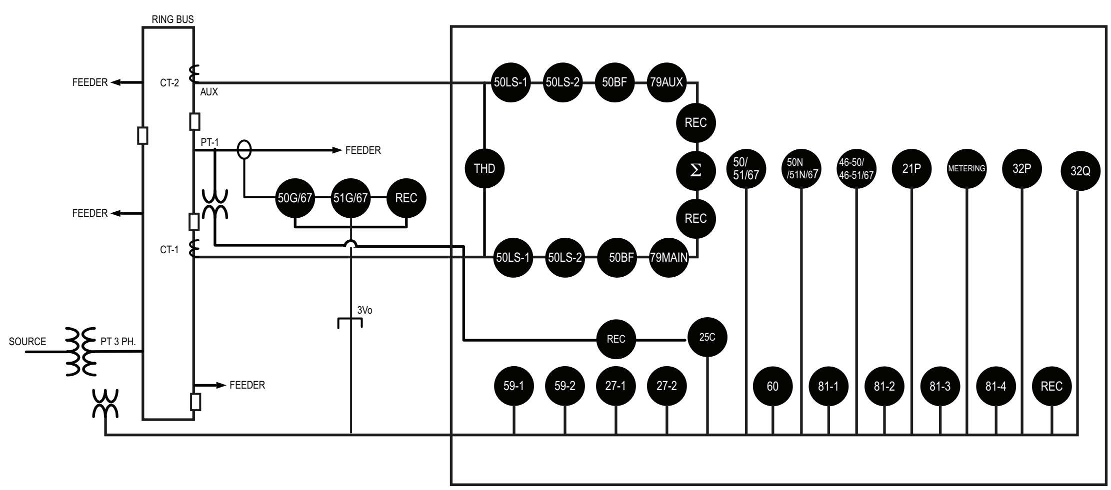
To provide a complete package of protection and control, F-PRO provides other functions such as:

- ring bus capability to protect and monitor lines connected to ring schemes Current inputs are labelled Main and Aux inputs to denote the breaker ring current inputs. Use F-PRO with straight single breaker line schemes by using the main current inputs
- breaker failure detection and monitoring
- 2 completely dedicated four shot reclosers devices 79 Main and 79 Aux to control line reclosing needs along with device 25C Sync Check/Dead Bus/Dead Line supervision
- Measured Neutral Overcurrent Protection (50G/51G/67) using IGnd CT

- Loss of Potential Alarm (60 LOP) Function
- low set overcurrent functions for each breaker as well as for the summated line currents that include phase, neutral, 32P, 32Q, 21P and negative sequence functions
- Watt, VAR flow detectors as well as undervoltage, overvoltage and over/under frequency functions (Freq ROC) to provide protection for issues such as inter-tie protection needs
- ProLogic provide a flexible way to address special protection needs. Ten ProLogic statements are provided
- Breaker Logic, Group Logic, Setting Group, Demand/Trend Metering

Relay Control Panel (RCP) is the Windows graphical user interface software tool provided with all 3000, 4000 series and higher (new generation) ERL relays to communicate, retrieve and manage records, event logs, fault logs, manage settings (identification, protection, SCADA etc.,), display real time metering values, view, analyze, and export records in COMTRADE format.

In addition to the protection functions the relay provides fault recording (96 samples/cycle) to facilitate analysis of the power system after a disturbance has taken place. The triggers for fault recording are established by programming the output matrix and allowing any internal relay function or any external input or any GOOSE messaging input to initiate recording.



Analog Inputs
4 Analog Voltages
1 Three-phase Input
1 Single-phase Input
7 Analog Currents
2 Three-phase Inputs
1 Single-phase Input

Outputs
14 Output Contacts
1 Relay Inoperative Alarm Contact

Inputs
9 External Inputs

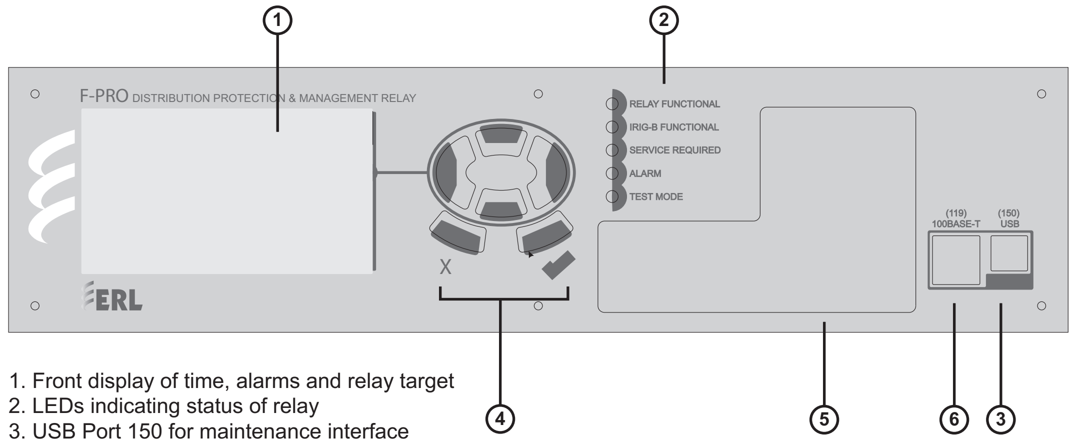
Demand/Trend Metering (Primary/Secondary)
Real Power (MW IN and OUT)
Reactive Power (MVAR IN and OUT)
3 Phase Voltages (Va, Vb, Vc)
3 Phase Currents (Ia, Ib, Ic)
Real Energy (MWh IN and OUT)
Reactive Energy (MVARh IN and OUT)
THD Level (%)
System Frequency

Fault Recording
4 Voltages
7 Currents
97 Unique Events

Metering (Front Display)
Primary Pos. Sequence Volts, Amps, Primary Watts and VARs
Frequency
THD (Total Harmonic Distortion)
Secondary Phase Voltage, Current, Phase Angle (A, B, C)
Energy Values MWh IN and OUT MVARh IN and OUT
3I0
Logic
Digital I/O
I*I*t

Figure 1.1: F-PRO Relay Function Line Diagram

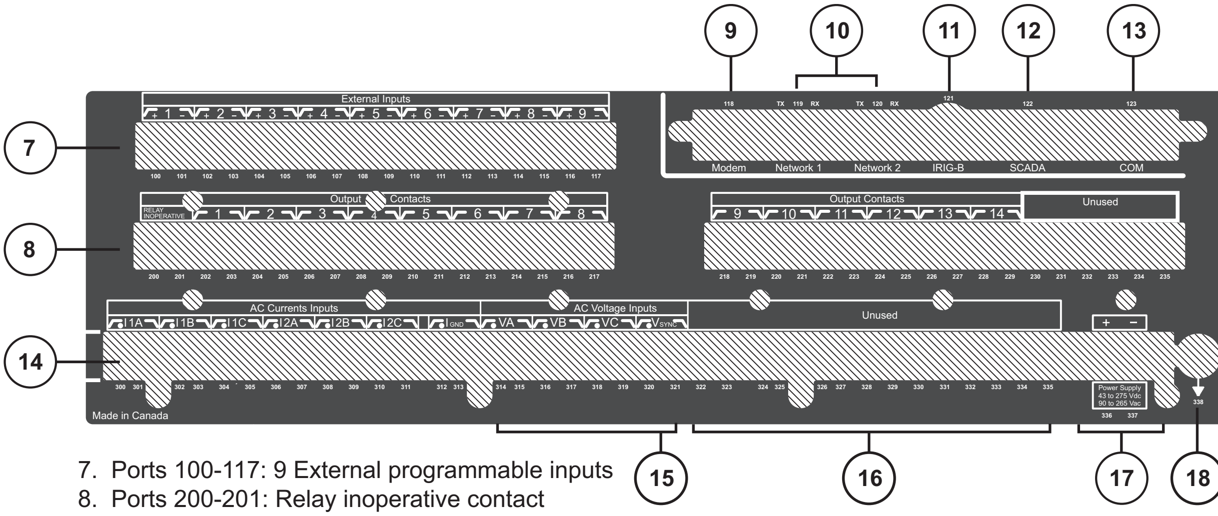
1.2 Front View



1. Front display of time, alarms and relay target
2. LEDs indicating status of relay
3. USB Port 150 for maintenance interface
4. Push buttons to manipulate information on settings, display and to clear targets
5. 11 Target Programmable LEDs
6. Ethernet Port 119

Figure 1.2: F-PRO Front View

1.3 Back View



7. Ports 100-117: 9 External programmable inputs
8. Ports 200-201: Relay inoperative contact
   Ports 202-229: 14 Programmable output contact
   Ports 230-235: Unused
9. Port 118: Internal modem
10. Port 119-120: 100BASE-T or 100BASE-FX Ethernet ports
11. Port 121: External clock, IRIG-B modulated or unmodulated
12. Port 122: SCADA
13. Port 123: Direct/Modem RS-232 Port
14. Ports 300-313: AC current input
15. Ports 314-321: AC voltage input
16. Ports 322-335: Unused
17. Ports 336-337: Power supply
18. Port 338: Chassis Ground

Figure 1.3: F-PRO Back View

AC Current and Voltage Inputs

F-PRO is provided with terminal blocks for up to 7 ac currents and 4 ac voltages.

Each of the current and voltage input circuits has polarity (•) marks.

A complete schematic of current and voltage circuits is shown, for details see “AC Schematic Drawing” in Appendix I and “DC Schematic Drawing” in Appendix J.

External Inputs

The F-PRO relay contains 9 programmable external inputs. External dc voltage of 48 V, 110 V, 125 V, 220 V or 250 V dc are possible depending on the configuration selected.

Output Relay Contacts

The F-PRO relay has 14 output relay contacts. Each contact is programmable and has breaker tripping capability. All output contacts are isolated from each other. The output contacts are closed for a minimum of 100 ms after operation.

Relay Inoperative Alarm Output

If the relay becomes inoperative, then the Relay Inoperative Alarm output contact closes and all tripping functions are blocked.

1.4 Model Options/Ordering

The relay is available as a horizontal mount, for details see “Mechanical Drawings” in Appendix G.

The relay is available with an optional internal modem card.

The two rear Ethernet ports can be ordered as one copper-one optical port or both optical ports or both copper ports.

The Current Transformer (CT) inputs are 1 A nominal or 5 A nominal.

The external inputs are 48, 110/125 or 220/250 Vdc.

The system base frequency is either 50 Hz or 60 Hz.

All of the above options must be specified at the time of ordering.

2 Setup and Communications

2.1 Introduction

This chapter discusses setting up and communicating with the relay including the following:

- Power supply
- Inter-Range Instrumentation Group time codes (IRIG-B) time input
- Communicating with the relay using a network link, a direct serial link and a modem link (internal, external)
- Using Relay Control Panel to access the relay’s user interface
- Using HyperTerminal to access the relay’s maintenance menu
- Setting the Baud rate
- Accessing the relay’s Supervisory Control And Data Acquisition (SCADA) services

2.2 Power Supply

A wide range power supply is standard. The operating range is 43 – 275 Vdc, 90 – 265 Vac, 50/60 Hz. To protect against possible short circuit in the supply use an inline fuse or circuit breaker with a 5 A rating. Make the chassis ground connection to ensure proper operation and safety.

There are no power switches on the relay. When the power supply is connected, the relay starts its initialization process and takes about 40 seconds to complete showing the green Relay Functional LED.

Case Grounding

Ground the relay to station ground using the case-grounding terminal at the back of the relay, for details see for details see Figure 1.3: F-PRO Back View on page 1-4.

WARNING!

Ground the relay to station ground using the case-grounding terminal at the back of the relay, for details see Figure 1.3: F-PRO Back View on page 1-4.

2.3 IRIG-B Time Input

The relay is equipped to handle modulated or unmodulated GPS satellite time IRIG-B signals. The IRIG-B time signal is connected to the BNC connection on the back of the relay. When the IRIG-B signal is provided to the relay the IRIG-B functional Light-Emitting Diode (LED) comes on and the relay clock is referenced to this signal. No settings are required to differentiate between modulated or unmodulated signals; this is automatically detected by the relay.

Enable or disable the IEEE 1344 extension in the Relay Control Panel. The enabled mode allows the year to be received from the IRIG-B signal. If the available IRIG-B signal has no year extension, this setting should be disabled.

2.4 Communicating with the Relay Intelligent Electronic Device (IED)

Connect to the relay to access its user interface and supervisory control and data acquisition (SCADA) services by:

- Front USB 2.0 interface (maintenance)
- 1 front and 2 rear Ethernet network links (user interface and SCADA)
- Direct serial link (user interface and SCADA)
- External or internal modem link (user interface only)

The relay has a front panel USB port (Port 150) and 1 front Port 119 and 1 rear Ethernet Port 120 and 2 rear serial Ports 122 and 123) to provide direct access to its user interface and SCADA services.

The relay’s user interface is accessed through the Relay Control Panel.

2.5 USB Link

The PC must be appropriately configured for USB communication.

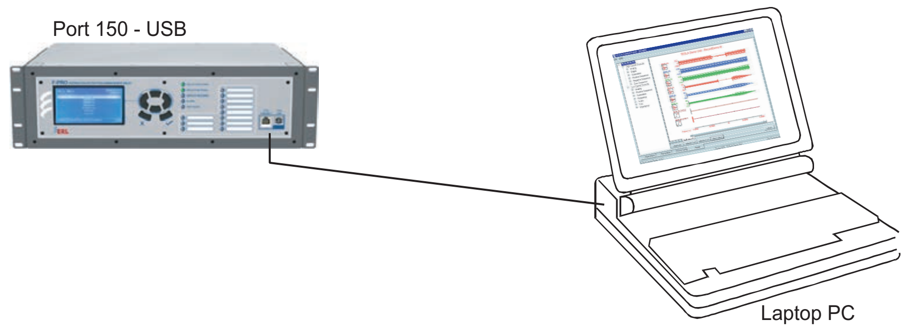


Figure 2.1: USB Link

USB Driver Installation

To create an USB link between the relay and the computer, first the USB driver for the ERLPhase 4000 series device needs to be installed, as follows:

Unzip the file (can be obtained from ERL website):

ERLPhase_USB_driver.zip

In this case we assume you unzipped to the desktop.

In Windows XP or Windows 7

Connect a USB port of the PC to Port 150 (USB front) of the FPRO-4000. The FPRO-4000 was already powered on.

In the window

"Welcome to the Found New Hardware Wizard"
"Can Windows connect to Windows Update to search for software?"

Check the option "No, not this time".

In the window

"This wizard helps you install software for:"
"ERLPhase 4000 Series Device"
"What do you want the wizard to do?"

Check the option "Install from a list or specific location (Advanced)".

In the window

"Please choose your search and installation options"
"Search for the best driver in these locations"

Uncheck the option “Search removable media (floppy, CD-ROM.)”.

Check the option “Include this location in the search”.

Browse for the following folder:

C:\WINDOWS\tiinst\TUSB3410

In the window

“Hardware Installation”
“The software you are installing for this hardware”
“ERLPhase 4000 Series Device”
“has not passed Windows Logo testing to verify its compatibility with Windows XP” or “Windows can’t verify the publisher”

Hit *Continue Anyway*.

In the window

“Completing the Found New Hardware Wizard”
“The wizard has finished installing the software for”

“ERLPhase 4000 Series Device”

Hit *Finish*.

To verify the installation was successful, and to which comm port is the ERLPhase 4000 Series Device configured, do the following:

In Windows XP

Start > Control Panel>Performance and Maintenance>System >Hardware > Device Manager > Ports

or (if using Control Panel’s Classic View)

Start > Control Panel > System > Hardware >Device Manager >Ports

In Windows 7 ‘small icons’ view, go to

Start>Control Panel>Device Manager>Ports.

Look for the port number associated to this device.

“ERLPhase 4000 Series Device”
Look for a COM#, where “#” can be 1, 2, 3, etc. Leave the default settings for this port.

It is recommended to restart the PC after the USB driver installation.

The default baud rate for the relay USB Port 150 is 115200, however to double check it login to the relay display and go to:

Main Menu > System > Relay Comm Setup

2.6 Network Link

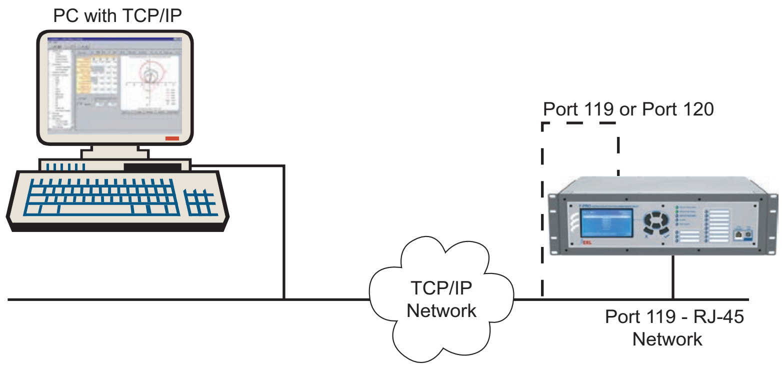


Figure 2.2: Network Link

Access both the relay's user interface and DNP3 SCADA services simultaneously with the Ethernet TCP/IP LAN link through the network ports Port 119 and Port 120. The rear Port 119 and 120 are either 100BASE-T copper interface with an RJ-45 connector or 100BASE-FX optical interface with an ST style connector. Each port is factory configurable as a copper or optical interface. The front Port 119 is 100BASE-T copper interface with an RJ-45 connector.

DNP3 SCADA services can also be accessed over the LAN, for details see "Communication Port Details" on page 2-15.

Connect to the Ethernet LAN using a Cat 5 cable with an RJ-45 connector or 100BASE-FX 1300 nm, multimode optical fiber with an ST style connector.

By default, the Port 119 is assigned with an IP address of 192.168.100.80 Port 120 is assigned with an IP address of 192.168.101.80. If this address is not suitable, it may be modified using the relay's Maintenance Menu. For details see "Using HyperTerminal to Access the Relay's Maintenance Menu" on page 2-9.

2.7 Direct Serial Link

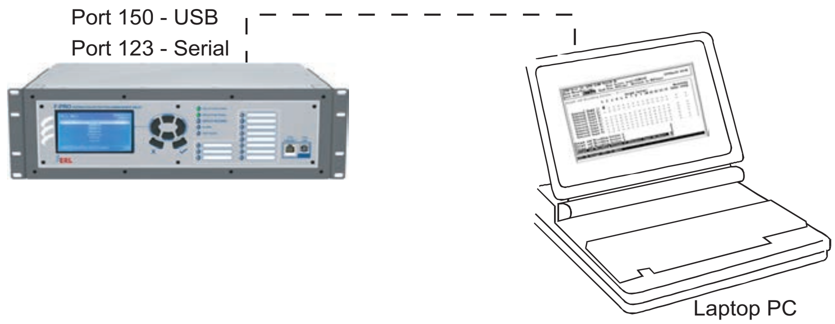


Figure 2.3: Direct Serial Link

To create a serial link between the relay and the computer, connect the computer's serial port and Port 123 on the relay's rear panel provided the port is not configured for modem use.

The serial ports are configured as EIR RS-232 Data Communications Equipment (DCE) devices with female DB9 connectors. This allows them to be connected directly to a PC serial port with standard straight-through male-to female serial cable, for pin-out details see "Communication Port Details" on page 2-15. Rear Port 122 is for SCADA and Port 123 can be used for direct serial access and external modem.

Ensure the relay port and the PC's port have the same baud rate and communications parameter, see "Maintenance Menu Commands" on page 2-11.

2.8 Modem Link

External

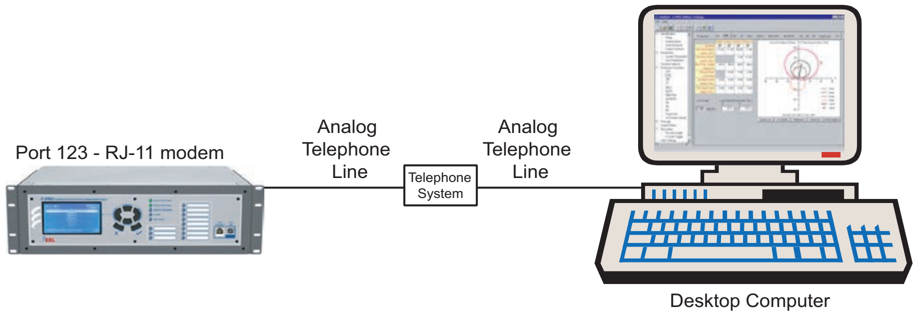


Figure 2.4: External Modem Link

Using an external modem, access the relay's user interface through a telephone link between the relay and the computer.

Connect the serial port on the external modem to the Port 123 on the relay's rear panel. Both devices are configured as RS-232 DCE devices with female connectors, so the cable between the relay and the modem requires a crossover and a gender change. Alternatively, use the ERLPhase modem port adapter provided with the relay to make Port 123 appear the same as a PC's serial port. A standard modem-to-PC serial cable can then be used to connect the modem and the relay. For pin-out details see "Communication Port Details" on page 2-15.

Connect the modem to an analog telephone line or switch using a standard RJ-11 connector.

Configure the relay's Port 123 to work with a modem. Log into the relay through Relay Control Panel, go to *Utilities>Communication* and select *port 123*. Set the *Baud Rate* as high as possible – most modems handle 57,600 bps. The *Initialize* setting allows the user to set the control codes sent to the modem at the start of each connection session. The factory defaults are: "M0S0=0&B1" for an external modem and "M0S0=0" for an internal modem.

Internal

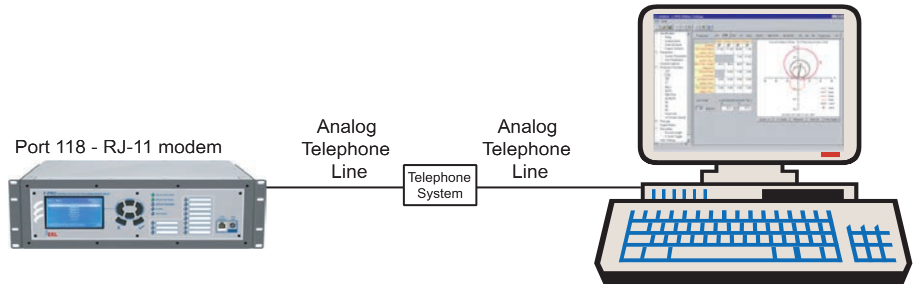


Figure 2.5: Internal Modem Link

Access the relay's user interface through a telephone link between the relay and the computer using an optional internal modem. If the modem has been installed, Port 118 on the rear panel is labelled "INTERNAL MODEM."

Connect the relay's Port 118 to an analog telephone line or switch using a standard RJ-11 connector.

When an internal modem is installed, the relay's Port 118 is used to interface to the modem internally. Appropriate Port 118 settings are configured at the factory when the internal modem is installed. The factory defaults are: "M0S0=0&B1" for an external modem and "M0S0=0" for an internal modem.

2.9 Using HyperTerminal to Access the Relay's Maintenance Menu

This section describes how to configure a standard Windows VT-100 terminal program on the PC for use with the relay.

The computer must be connected to the relay via the front USB port 150.

The relay is accessed using a standard VT-100 terminal style program on the computer, eliminating the need for specialized software. Any terminal program that fully supports VT-100 emulation and provides z-modem file transfer services can be used. HyperTerminal, which is included in Windows XP and is also available separately as HyperTerminal PE, is used here as an example.

Configure the terminal program as described in Table 2.1:Terminal Program Setup and link it to the appropriate serial port, modem or TCP/IP socket on the computer.

Table 2.1: Terminal Program Setup

Baud rate	Default fixed baud rate 115,200 N81 (no parity, 8 data bits, 1 stop bit).
Data bits	8
Parity	None
Stop bits	1
Flow control	Hardware or Software. Hardware flow control is recommended. The relay automatically supports both on all its serial ports.
Function, arrow and control keys	Terminal keys
Emulation	VT100
Font	Use a font that supports line drawing (e.g. Terminal or MS Line Draw). If the menu appears outlined in odd characters, the font selected is not supporting line drawing characters.

To configure HyperTerminal follow these instructions:

In Windows 7 open HyperTerminal PE; in Windows XP go to

Start > All Programs > Accessories > Communications > HyperTerminal

If "Default Telnet Program?" windows pops up,

Check "Don't ask me this question again"

Hit *No*.

First time use of HyperTerminal will ask for "Location Information".

Fill with appropriate information, e.g.:

"What country/region are you in now"
Choose "Canada"

"What area code (or city code) are you are in now?"
Enter "306"
"If you need to specify a carrier code, what is it?"
Enter "", i.e. leave blank
"If you dial a number to access an outside line, what is it?"
Enter "".
"The phone system at this location uses:"
Choose "Tone dialing".

Hit *OK*.

First time use of HyperTerminal will show "Phone and Modem Options".

Hit *Cancel*.

HyperTerminal will show initially "Connection Description".

Enter a name for the relay, e.g: "FPRO4000".

Hit *OK*.

In the window "Connect To"

"Connect using"

Choose "COM#", where "#" was obtained previously in Section 2.5 USB Link, after installing the USB driver.

Let's assume in this case it is COM3.

In the window "COM3 Properties" choose:

"115200"

"8"

"None"

"1"

"Hardware"

Hit *Apply* then hit *OK*

At this time the connection should already be established.

Hit *Enter* in the terminal window.

Login as **maintenance** in lower case.

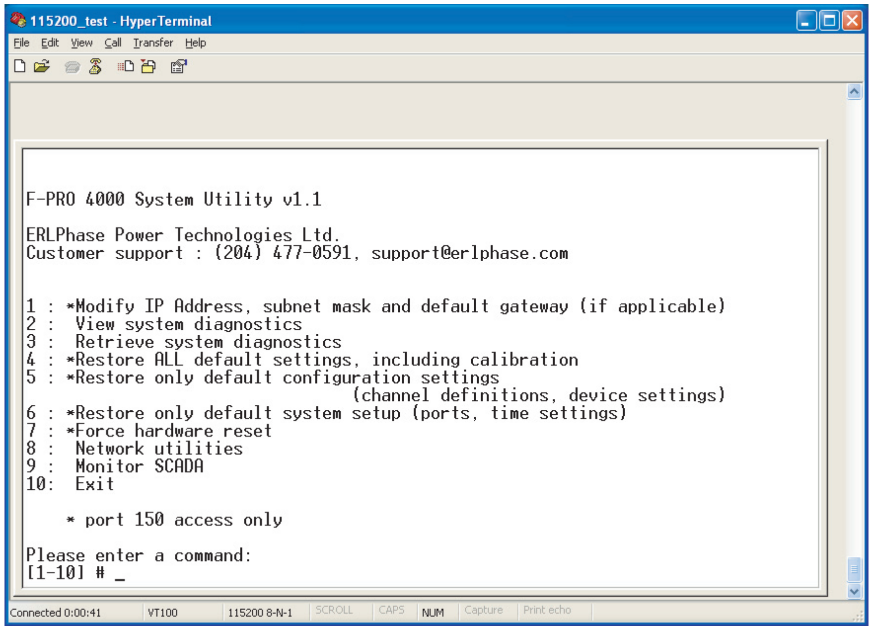


Figure 2.6: Maintenance Menu

Maintenance Menu Commands

Commands 1, 4, 5, 6 and 7 are Port 150 access only.

Table 2.2: Maintenance Menu Commands

Modify IP address	Modifies the LAN IP addresses, network mask, default gateway and IEC61850 network port assignment.
View system diagnostic	Displays the internal status log.
Retrieve system diagnostics	Automatically packages up the internal status log plus setting and setup information and downloads it in compressed form to the computer. This file can then be sent to our customer support to help diagnose a problem.
Restore settings (commands 4, 5 and 6)	Use these commands to force the system back to default values, if a problem is suspected due to the unit's settings, calibration and/or setup parameters.
Force hardware reset	Manually initiates a hardware reset. Note that the communication link is immediately lost and cannot be reestablished until the unit completes its start-up.
Network utilities	Enters network utilities sub-menu.
Monitor SCADA	Shows real time display of SCADA data.

Table 2.3: Network Utilities Menu Commands	
View protocol statistics	View IP, TCP and UDP statistics
View active socket states	View current states of active sockets
View routing tables	View routing tables
Ping	Check network connection to given point
Exit network utilities	Exit network utilities menu and return to Maintenance Menu Commands

2.10 Firmware Update

The relay has an update login that can be accessed by a connection through a VT100 terminal emulator (such as HyperTerminal). This login is available only from Port 150.

1. Use the terminal program to connect to Port 150.
2. Select *Enter*, the terminal responds with a login prompt.
3. Login as **update** in lower case.

The firmware update is used to update the relay's software with maintenance or enhancement releases. Please see the F-PRO Firmware Update Procedure documentation that comes with the firmware update for instructions on how to update the firmware on the relay.

2.11 Setting the Baud Rate

> The baud rate is available on the LCD screen from the top level menu selecting *System* then *Relay Comm Setup*.

Direct Serial Link

For a direct serial connection, both the relay and the computer must be set to the same baud rate.

To change the baud rate of a relay serial port:

1. The user needs to log into the relay as **Change** (any port) or **Service** (USB port only) using RCP.
2. Then choose *Utilities>Communication* tab.

Modem Link

Unlike a direct serial link, the baud rates for a modem link do not have to be the same on the computer and on the relay. The modems automatically negotiate an optimal baud rate for their communication.

The baud rate set on the relay only affects the rate at which the relay communicates with the modem. Similarly, the baud rate set in HyperTerminal only affects the rate at which the computer communicates with its modem. Details on how to set these respective baud rates are described above, except that the user modifies the Port 123 baud rate on the relay and the properties of the modem in HyperTerminal.

2.12 Accessing the Relay’s SCADA Services

The relay supports DNP3 (Level 2) and Modbus SCADA protocols as a standard feature on all ERLPhase relays. DNP3 is available through a direct serial link or the Ethernet LAN on top of either TCP or UDP protocols. The Modbus implementation supports both Remote Terminal Unit (RTU) binary or ASCII modes and is available through a direct serial link.

The relay’s Port 122 is dedicated for use with Modbus or DNP3 serial protocols. Port 122 uses standard RS-232 signalling. An external RS-232<->RS-485 converter can also be used to connect to an RS-485 network.

For details on connecting to serial Port 122 see “Communicating with the Relay Intelligent Electronic Device (IED)” on page 2-2 and “Communication Port Details” on page 2-15.

The DNP3 protocol can also be run across the Ethernet LAN. Both DNP over TCP and DNP over UDP are supported. For details on connecting to the Ethernet LAN see “Network Link” on page 2-5.

Complete details on the Modbus and DNP3 protocol services can be found in the Appendices, for details see “Modbus RTU Communication Protocol” in Appendix E and “DNP3 Device Profile” in Appendix F.

Protocol Selection

To select the desired SCADA protocol go to F-PRO 4000 Offliner SCADA communications section. Select the protocol and set the corresponding parameters.

Communication Parameters

Port 122’s communication parameters are set in the F-PRO 4000 Offliner SCADA communications section. Both the baud rate and the parity bit can be configured. The number of data bits and stop bits are determined automatically by the selected SCADA protocol. Modbus ASCII uses 7 data bits. Modbus RTU and DNP Serial use 8 data bits. All protocols use 1 stop bit except in the case where either Modbus protocol is used with no parity; this uses 2 stop bits, as defined in the Modbus standard.

Diagnostics

Protocol monitor utilities are available to assist in resolving SCADA communication difficulties such as incompatible baud rate or addressing. The utilities can be accessed through the Maintenance Menu Commands, see “Maintenance Menu Commands” on page 2-11

2.13 Communication Port Details

Table 2.4: Communication Port Details

Location	Port	Function
Front Panel	119	RJ-45 receptacle, 100BASE-T Ethernet interface. Default IP = 192.168.100.80 Used for user interface access or SCADA access through Ethernet LAN.
Front Panel	150	USB-B receptacle, High speed USB 2.0 interface Used for user interface access Default fixed baud rate 115,200 N81 (no parity, 8 data bits, 1 stop bit).
Rear Panel	118	RJ-11 receptacle, Internal modem interface. Default Baud rate 38,400 N81 (no parity, 8 data bits, 1 stop bit)
Rear Panel	119	Rear panel, RJ-45 receptacle or ST type optical receptacle (factory configured). 100BASE-T or 100BASE-FX (1300nm, multimode) Ethernet interface. Same subnet as front panel port 119. Used for user interface access or IEC61850/DNP SCADA access through Ethernet LAN.
Rear Panel	120	ST type optical receptacle. 100BASE-FX (1300 nm, multimode) Ethernet interface. Used for user interface access or IEC61850/DNP SCADA access through Ethernet LAN
Rear Panel	121	BNC receptacle, IRIG-B Interface. Modulated or un-modulated, 330 ohm impedance.
Rear Panel	122	RS-232 DCE female DB9. Used for SCADA communication. Default Setting: 19,200 baud O71 (odd parity, 7 data bits, 1 stop)
Rear Panel	123	RS-232 DCE female DB9. Used for: • User interface access through a direct serial connection. • Default Setting: 9600 baud N81 (no parity, 8 data bits, 1 stop bit). • User interface access through an external modem. The optional ERLPhase Modem Adapter converts this port to a Data Terminal Equipment (DTE) to simplify connection to an external modem.

Table 2.5: Signal connections to pins on Relay Port

Signal Name	Direction PC<-> Relay	Pin # on the Relay Port
DCD	←	1
RxD	←	2
TxD	→	3
DTR	→	4
Common		5
DSR	←	6
RTS	→	7
CTS	←	8
No connection		9

Notes:
Relay is DCE, PC is DTE.
Pins 1 and 6 are tied together internal to the relay.

Table 2.6: Cable Pin Connections

Male DB-9 Cable End for Relay Port	Female DB-9 Cable End for Computer Port
Pin # on Cable	Pin # on Cable
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Table 2.7: Signal name connections to pins on Modem Adapter

Signal Name	Direction Modem <-> Relay	Pin # on the Modem Adapter
DCD	→	1
RxD	→	2
TxD	←	3
DTR	←	4
Common		5
DSR	→	6
RTS	←	7
CTS	→	8
No connection		9

Notes:
Relay (with modem adapter) is DTE, modem is DCE.
Pins 1 and 6 are tied together internal to the relay.

3 Using the IED (Getting Started)

3.1 Introduction

This section provides information on the start-up sequence and ways to interface with the relay. Descriptions of the Front Panel Display, Terminal Mode and Metering Data are provided.

3.2 Start-up Sequence

When the power supply is connected, the following initialization initializing sequence takes place:

Table 3.1: Initialization Sequence

TEST MODE — red LED on	when power applied
RELAY FUNCTIONAL — green LED on	within 5 seconds after power applied
TEST MODE — red LED off then on	within 10 seconds
Front Display — on	on within 20 seconds after power applied
TEST MODE — red LED off	within 20 seconds after power applied

When the Relay Functional LED comes on, it indicates that the DSP is actively protecting the system.

When the test mode LED goes off, the relay is capable of recording and communicating with the user.

3.3 Interfacing with the Relay

The following ways can be used to interface with the relay:

- Front panel display
- Terminal mode (for maintenance and firmware upgrade)
- Relay Control Panel

3.4 Front Panel Display

The front panel display is the fastest and easiest way of getting information from the relay.

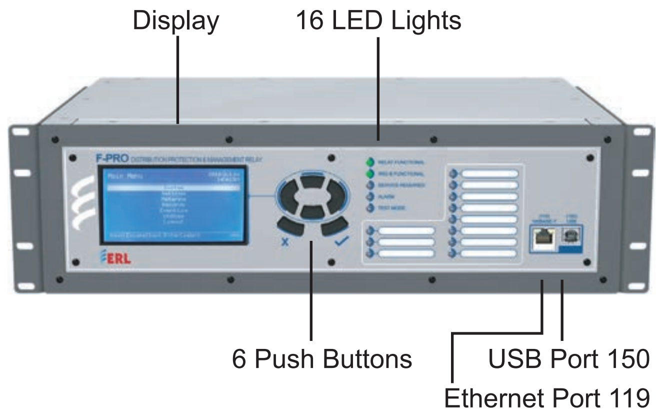


Figure 3.1: Front Panel Display

The display, the 16 LED lights and the 6 push buttons, provide selective information about the relay.

LED Lights

Table 3.2: Description of LED Lights	
Relay Functional	Indicates when the relay is functional. When the Relay Functional green LED goes on, the rear Relay Inoperative contact changes to an open and the protective functions become functional.
IRIG-B Functional	Indicates the presence of a valid IRIG-B time signal where the LED is on.
Service Required	Indicates the relay needs service. This LED can be the same state as the Relay Functional LED or can be of the opposite state depending on the nature of the problem. The following items bring up this LED: • DSP failure - protection difficulties within the relay. • Communication failure within the relay. • Internal relay problems.
Test Mode	Occurs when the relay output contacts are intentionally blocked. Possible reasons are: • Relay initialization on startup • User interface processor has reset and is being tested. The user cannot communicate with the relay through the ports until the front display becomes active and the TEST MODE LED goes out. Normally, the red Target LED remains off after this start-up unless the relay had unviewed target messages.
Alarm	Occurs when an enabled relay function picks up. The red Alarm LED should be off if there are no inputs to the relay. If the Alarm LED is on, check the event log messages which are available through the menu system.

Table 3.2: Description of LED Lights

Target LED Number	Description (Default values)
1	Any device 21P trip operation (phase distance - 21P1, 21P2
2	Any device 50G1/67 trip
3	Any device 50 or 51 trip operation (phase overcurrent - 50 or 51, neutral overcurrent - 50N or 51N, negative sequence overcurrent 46-50 or 46-51)
4	Any device 50BF trip operation (breaker failure - 50BF Main-1, 50BF Main-2, 50BF Aux-1, 50BF Aux-2)
5	Any device 81 trip operation (over/under-frequency - 81-1, 81-2, 81-3, 81-4)
6	32P Directional Power Trip
7	External Input
8	50LS Main1 & 50LS Main2
9	ProLogic 1 - 8
10	Breaker Logic
11	60LOP

Target LED assignments are the default values but are configurable by the user through the Offliner settings (output matrix configuration).

Push Buttons

Table 3.3: Identification of Push Buttons

Up, Down, Right, Left, Enter, Escape	Used to navigate the front panel screens.

Display

The basic menu structure for navigation of the LCD screen is given below:

Table 3.4: Navigation of the LCD Screen

Main Screen					
	View / Change / Service : Choice Menu				
	Enter Password				
	Main Menu				(V)
		System			(V)
			Relay Identification		(V)
			Relay Comm Setup		(V)
		Settings			
			System Parameters		
			Record Length		
			Setting Group		
				Setting Group 1	
				Setting Group 2	
				Setting Group 3	
				Setting Group 4	
				Setting Group 5	
				Setting Group 6	
				Setting Group 7	
				Setting Group 8	
		Metering			(V)
			Analog		(V)
				Analog Inputs	(V)
				Line Data	(V)
			Energy		(V)
			I*I*t		(V)
			Demand		
			External Input		
			Output Contact		
			Logic		(V)
				Internal Logic 1	(V)
				Internal Logic 2	(V)
				ProLogic	(V)

Table 3.4: Navigation of the LCD Screen

		Group Logics		(V)
		Virtual Inputs		(V)
		Breaker Logic Count		
		Breaker Logic		
Records				(V)
	View Record List			(V)
	Fault Recording			(C,S)
	Event Recording			
	Trend Recording			
Fault Log				
	Fault List			
Event Log				(V)
	Event List			
Utilities				(V)
	Setup			(V)
		Timeouts		(V)
		Time Settings		(V)
		Set Manual Time		(V)
		Set DST Time		(V)
	Maintenance			(V)
		Output Contacts Control		(S)
		Virtual Inputs Control		(C,S)
		Setting Groups Control		(C,S)
		Erase		(C,S)
			Erase Records	(C,S)
			Erase Event Logs	(C,S)
	Network			(V)
		Network Protocol Stats		(V)
		Active Sockets		(V)
		Routing Tables		(V)
		Ping		(V)
Logout				(V)

Where the access levels required to access each are indicated by:

V: view

C: change

S: service

To login into the LCD menu structure, follow these steps:

Figure 3.2: Main Screen

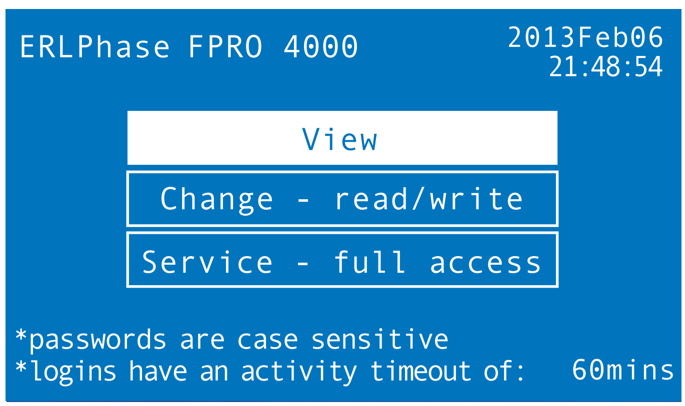


Figure 3.3: View / Change / Service: Choice Menu

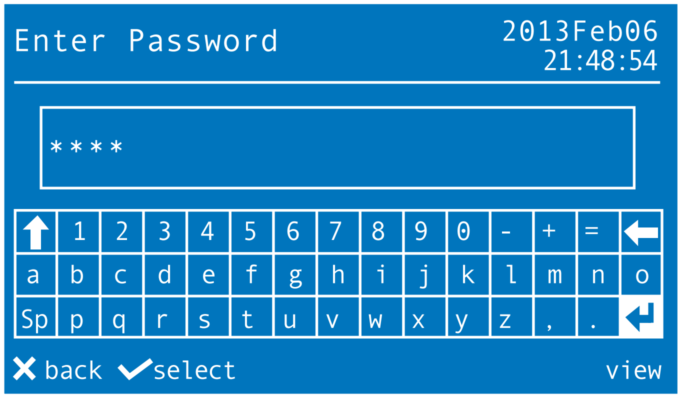


Figure 3.4: Enter Password

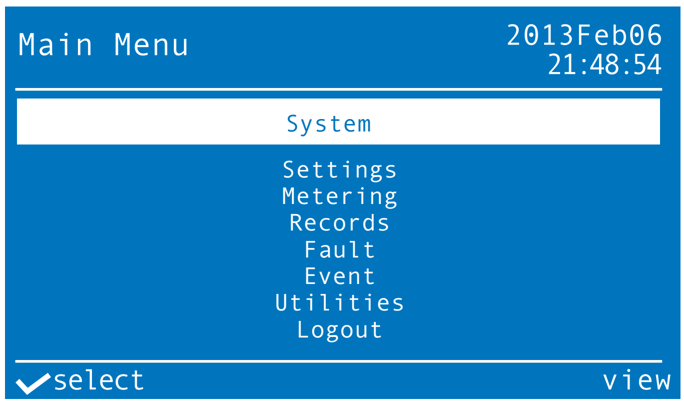


Figure 3.5: Main Menu

In the Main Screen, hit *Enter*.

In the View / Change / Service: Choose Menu screen, choose desired access level, hit *Enter*.

In the Enter Password screen, enter appropriate password, hit *Enter* on the return character (right bottom one)

The Main Menu screen should appear.

Note: The default passwords are (remove quotation marks)

View Access "view"

Change Access "change"

Service Access "service"

3.5 Terminal Mode

The terminal mode is used to access the relay for maintenance functions see "Using HyperTerminal to Access the Relay's Maintenance Menu" on page 2-9.

3.6 Relay Control Panel

RCP is used for all user interface. A short description of the RCP configuration to connect to a relay is given here. Please refer to the Relay Control Panel User Manual for details.

Follow this sequence to configure RCP for USB link to the relay.

1. Execute.

   Relay Control Panel.exe

2. Execute.

   F-PRO 4000 Offliner.exe

3. Install Null Modem Driver.

   Please refer to the Relay Control Panel User Manual for details.

4. Run Relay Control Panel.

   Go to:

   Start > *All Programs* > *ERLPhase* > *Relay Control Panel* > *Relay Control Panel*

   First time RCP is run.

   Hit *Add New*.
   "Add New Relay"

      Choose Communication > Direct Serial Link.

      Hit *Get Information From Relay.*

      Then RCP will communicate with the FPRO-4000 and retrieve information to fill required fields.

      When this is done, hit *Save Relay*.

      If the window "Relay already exists..." pops up, you may need to rename the relay changing the "Relay Name" in the "Relay Definition" category, before saving.

   After first time, in "Select Relay", choose relay and hit *Connect*.

   In "Relay Password Prompt"

      Choose desired access level, enter appropriate password

      Note: Default passwords are listed below (remove the quotation marks)

         View Access "view"

         Change Access "change"

         Service Access "service"

   The basic structure of the Relay Control Panel information, including basic actions available, is given below:

Table 3.5: Relay Control Panel Structure

			View	Change	Service
Relay Control Panel					
	Records			Trigger Fault	Trigger Fault
				Trigger Trend	Trigger Trend
				Trigger Event	Trigger Event
	Faults			Erase	Erase
	Events			Erase	Erase
	Metering				
		Input			
		Line Quant			
		Energy			
		I*I*t			
		Demand			
		Digital I/O			
		Bkr Logic			
		BkrLogiCnt			
		Logic			
		ProLogic			
		GroupLogic			
		Virtual			
	Utilities				
		Unit Identification			
		Communication			
		Time			
		Analog Input Calibration	N/A	N/A	
		Virtual Inputs	N/A	Latch/Pulse	Latch/Pulse
		Toggle Outputs	N/A	N/A	Close/Open
		Settings Group	N/A	Save	Save
		Clear Trend Log	N/A		

Table 3.5: Relay Control Panel Structure

	Clear Demand	N/A		
	Set/Reset Energy	N/A		
	Set/Reset I^2*t	N/A		
	Reset Breaker Logic Count	N/A		
	Passwords	N/A	N/A	
	Configuration			
	Present Settings	(Get From Relay)		
	Saved Settings		(Load to Relay)	(Load to Relay)

Notice that some options are not available (N/A) depending on the access level.

4 Protection Functions and Specifications

4.1 Protection and Recording Functions

Introduction

This section describes the equations and algorithms of the relay protection functions. All functions with time delay provide an alarm output when their pickup level is exceeded.

This section describes the equations and algorithms that define the F-PRO protection functions. The inverse time overcurrent functions and THD have an alarm output where their pickup level has been exceeded. Devices 27, 59, 50LS, 50BF, 81, 50/67, 50N/67, 46/50/67, 50G1/67, 32 and ProLogic have user-settable intentional delay. When an alarm occurs, the front alarm LED turns on and an output contact closes, if you have selected this option in the output matrix settings. The alarm indication resets when the function is allowed to reset.

50/51/67 Phase Overcurrent

Phase Overcurrent provides protection to the line. You can define forward, reverse or non-directional control on either 50 or 51 functions.

You can apply inverse and instantaneous overcurrent protection on the line currents with this function. If ac current inputs are applied to the relay from ring bus breakers, this current is summated to represent the total line current and is used with this overcurrent function. You can set directional control of 50/51. If voltage is lost, the element becomes non-directional.

The fault location allows the function to initiate a fault location if it operates.

Device 51 provides three IEC inverse time curve types, three IEEE inverse time curve types of overcurrent protection and one user-defined curve. The equation and the parameters of Device 50/51/67 are listed below.

ProLogic control can be used to supervise the inverse time integration of the 51.

Table 4.1: IEC and IEEE Curves

#	Characteristic	A	B	p	TR
1	IEC Standard Inverse	0.14	0	0.02	13.50
2	IEC Very Inverse	13.5	0	1.0	47.30
3	IEC Extremely Inverse	80.0	0	2.0	80.00
4	IEEE Moderately Inverse	0.0103	0.0228	0.02	0.97

Table 4.1: IEC and IEEE Curves					
5	IEEE Very Inverse	3.922	0.0982	2.0	4.32
6	IEEE Extremely Inverse	5.64	0.0243	2.0	5.82
7	User-defined	0.0010 to 1000.0	0.0 to 10.0	0.01 to 10.0	0.1 to 100.0

* These constants are copied from the IEEE standards; they are not given in the IEC standard.

For I > pickup

$$T(I) = TMS\left[B + \frac{A}{\left(\frac{I}{Ipickup}\right)^{p} - 1}\right] \tag{1}$$

For I < pickup

$$T(I) = \left[\frac{TR}{\left(\frac{I}{Ipickup}\right)^{2} - 1}\right]TMS \tag{2}$$

Table 4.2: 50/51/67 Phase Overcurrent	
50/67	Enable/disable
Directional	Forward, reverse, non-directional
Pickup	0.25 to 150 (5 A) 0.05 to 30 (1 A)
Pickup Delay	0.01 to 99.99 seconds (forward or reverse) 0.00 to 99.99 (non-directional)
51/67	Enable/disable
Directional	Forward, reverse, non-directional
Pickup	0.25 to 150 (5 A) 0.05 to 30 (1 A)
Curve Type	For details see “IEC and IEEE Curves” on page 4-1
TMS	0.01 to 10.00
A	0.0010 to 1000.0000
B	0.0000 to 10.0000
p	0.01 to 10.00
TR	0.10 to 100.00
Initiate Fault Location	Enable/disable
ProLogic Control	Enable/disable

50N/51N/67 Neutral Overcurrent

Neutral overcurrent provides protection for line-to-ground faults. You can define forward, reverse or non-directional control on either 50N or 51N functions. All the curve definitions are the same as the phase overcurrent except that this function uses 3I0 rather than phase current. The equation is:

For 3I0 > pickup

$$T(3I0) = TMS\left[B + \frac{A}{\left(\frac{3I0}{IPickup}\right)^{p} - 1}\right] \tag{3}$$

For 3I0 < pickup

$$T(3I0) = TMS\left[\frac{TR}{\left(\frac{3I0}{IPickup}\right)^{2} - 1}\right] \tag{4}$$

The Curve Type selection allows you to use a number of curves. All of these curves (Table 4.3, “50N/51N/67 Neutral Overcurrent,”) are generated by the equation shown on page 4-3. If you choose a user-selectable curve, it can be created using the parameters A, B and p.

The characteristic of the overcurrent function can be rescaled by clicking on the characteristics using the right mouse key and by making a box around the area of interest. The characteristic can be printed by pressing the Print Graph option.

Table 4.3: 50N/51N/67 Neutral Overcurrent

50N/67	Enable/disable
Directional	Forward, reverse, non-directional
Pickup	0.25 to 50.00 (5 A) 0.05 to 10.00 (1 A)
Pickup Delay	0.01 to 99.99 seconds (forward or reverse) 0.00 to 99.99 (non-directional)
51N/67	Enable/disable
Directional	Forward, reverse, non-directional
Pickup	0.25 to 50.00 (5 A) 0.05 to 10.00 (1 A)
Curve Type	For details see “IEC and IEEE Curves” on page 4-1
TMS	0.01 to 10.00
A	0.0010 to 1000.0000
B	0.0000 to 10.0000
p	0.01 to 10.00
TR	0.10 to 100.00

Table 4.3: 50N/51N/67 Neutral Overcurrent	
Initiate Fault Location	Enable/disable
ProLogic Control	Enable/disable

50G/51G/67 Measured Neutral Overcurrent

Measured Neutral Overcurrent function provides protection for line-to-ground faults. This function gets the current input from 7th Current channel. It is a simple overcurrent function which is tuned to fundamental frequency. This function can be directly applied as Normal Earth Fault or Sensitive Earth Fault (SEF) or Standby Earth Fault Protection. Using stabilizing resistor and metrosil, this element can also be applied as Restricted Earth Fault protection (REF) for Transformers.

Device 50G/51G/67 can be set as Non-directional, Forward or Reverse. The present directionality algorithm is based on 3V0 and IGND angle.

All the curve definitions are the same as the phase overcurrent.

For IG > pickup

$$T\langle IG\rangle = TMS\left[B + \frac{A}{\left(\frac{IG}{Pickup}\right)^{p} - 1}\right] \tag{5}$$

For IG < pickup

$$T(IG) = TMS\left[\frac{TR}{\left(\frac{IG}{Pickup}\right)^{2} - 1}\right] \tag{6}$$

The Curve Type selection allows you to use a number of curves available in this menu. All of these curve types are generated by the equation shown at the bottom of the screen. If you choose a user-selectable curve, it can be created using the parameters A, B and p. The characteristic of the over current function can be rescaled by clicking on the characteristics using the right mouse key and by making a box around the area of interest. The characteristic can be printed by pressing the Print Graph option.

Table 4.4: 50G/51G/67 Measured Neutral Over Current	
50G1/50G2/67	Enable/disable
Directional	Forward, reverse, non-directional
Pickup	0.05 to 10.00 (for 1 A) 0.25 to 50.00 (for 5 A)
Pickup Delay	0.00 to 99.99 Seconds (non-directional) 0.01 to 99.99 Seconds (forward or reverse)
51G/67	Enable/disable

Table 4.4: 50G/51G/67 Measured Neutral Over Current	
Directional	Forward, reverse, non-directional
Pickup	0.05 to 10.00 (for 1 A) 0.25 to 50.00 (for 5 A)
Curve Type	For details see “IEC and IEEE Curves” on page 4-1
TMS	0.01 to 10.00
A	0.0010 to 1000.0000
B	0.0 to 10.00
p	0.01 to 10.00
TR	0.10 to 100.00
Initiate Fault Location	Enable/disable
ProLogic Control	Enable/disable

46-50/46-51/67 Negative Sequence Overcurrent

Negative Sequence Overcurrent provides protection for any unbalanced faults. Functions 46-50/46-51/67 are similar to 50N/51N/67 except they use negative sequence current to drive their algorithms. You can define forward, reverse or non-directional control on either 46-50 or 46-51 functions. All the curve definitions are the same as the Phase Overcurrent. The only difference is that this function uses the negative sequence current (I2) rather than phase current. The equation is:

For I2 > pickup

$$T(I2) = TMS\left[B + \frac{A}{\left(\frac{I2}{Pickup}\right)^{p} - 1}\right] \tag{7}$$

For I2 < pickup

$$T(I2) = TMS\left[\frac{TR}{\left(\frac{I2}{Pickup}\right)^{2} - 1}\right] \tag{8}$$

Table 4.5: 46-50/46-51/67 Negative Sequence Overcurrent	
46-50/67	Enable/disable
Directional	Forward, reverse, non-directional
Pickup	0.25 to 50.0 (5 A) 0.05 to 10.0 (1 A)
Pickup Delay	0.01 to 99.99 seconds (forward or reverse) 0.00 to 99.99 (non-directional)

Table 4.5: 46-50/46-51/67 Negative Sequence Overcurrent	
46-51/67	Enable/disable
Directional	Forward, reverse, non-directional
Pickup	0.25 to 50.0 (5 A) 0.05 to 10.0 (1 A)
Curve Type	For details see “IEC and IEEE Curves” on page 4-1
TMS	0.01 to 10.00
A	0.0010 to 1000.0000
B	0.0000 to 10.0000
p	0.01 to 10.00
TR	0.10 to 100.00
Initiate Fault Location	Enable/disable
ProLogic Control	Enable/disable

50LS Low Set Overcurrent

F-PRO provides 2 sets of definite time delay overcurrent protection functions on each breaker: 50LS-1 Main, 50LS-2 Main, 50LS-1 Aux and 50LS-2 Aux. You can set the logic gate to either an AND or an OR gate to detect all 3 phases or any phase (of the 3 phases) overcurrent conditions. The definite time delay can be set to 0.0 for a instantaneous trip.

Auxiliary definite time delay functions are available to monitor main and auxiliary CT currents.

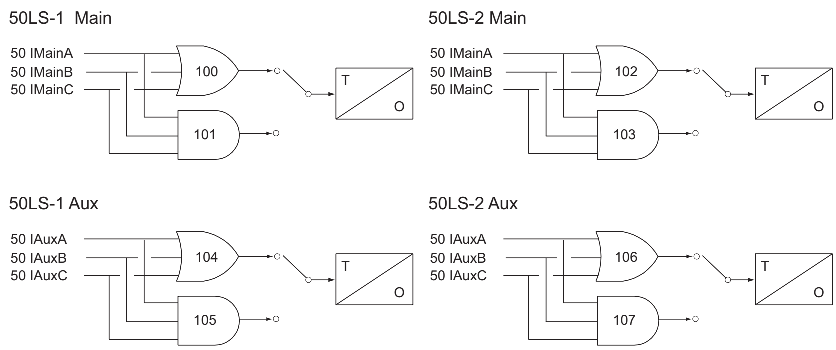


Figure 4.1: 50LS Low Set Overcurrent

Table 4.6: 50LS Low Set Overcurrent

50LS 1-Main/50LS 2-Main	Enable/disable
Pickup	0.10 to 150 amps (5 A) 0.02 to 30 amps (1 A)
Pickup Delay	0.00 to 99.99 seconds
50LS 1-Aux/50LS 2-Aux	Enable/disable
Pickup	0.10 to 150 amps (5 A) 0.02 to 30 amps (1 A)
Pickup Delay	0.00 to 99.99 seconds

50BF Breaker Failure

There are two sets of breaker failure protection functions, 50BF Main and 50BF Auxiliary – one for each breaker. When breaker failure is initiated by a trip or other internal logic (user-settable through the output matrix) and the breaker current still exists, two timers (T1 and T2 – user-settable) are started. After these timers are timed out, and if the current still exists indicating a breaker failure, the output of this function is set high. Use the two outputs of this function to trip another trip coil or the next level of breakers, such as bus breakers. The breaker failure protection logic diagram is shown below. Phase current supervision is fixed at 4% of I nominal and is shown for a 5 A relay.

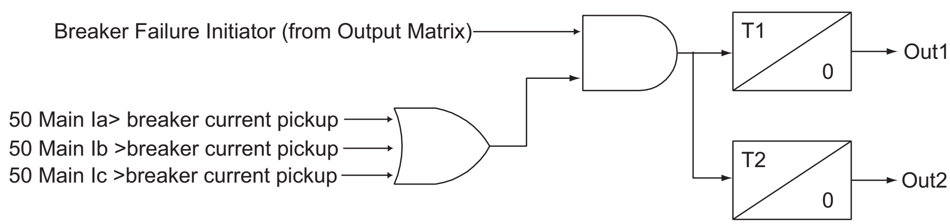


Figure 4.2: 50BF Main Breaker Failure

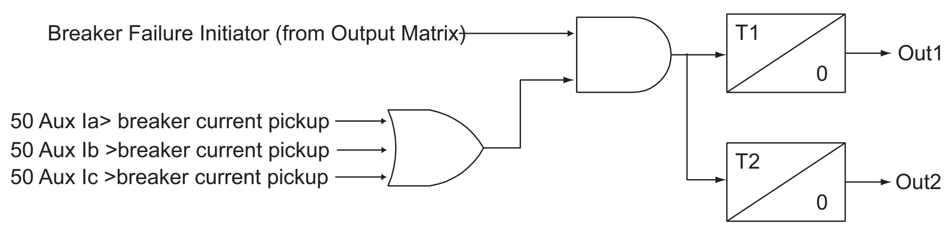


Figure 4.3: 50BF Aux Breaker Failure

Table 4.7: 50BF Breaker Failure

Setting Description	Range
50BF Main	Enable/Disable
Pickup Delay 1	0.01 to 99.99 seconds
Pickup Delay 2	0.01 to 99.99 seconds
Breaker Current Pickup	0.10 to 50.00 A (5 A) 0.02 to 10.00 A (1 A)
50BF Aux	Enable/Disable
Pickup Delay 1	0.01 to 99.99 seconds
Pickup Delay 2	0.01 to 99.99 seconds
Breaker Current Pickup	0.10 to 50.00 A (5 A) 0.02 to 10.00 A (1 A)

Directional Element

The directional element of F-PRO uses the memory-polarized, voltage-based positive sequence impedance ($Z_{pos\ mem}$) to determine the fault direction.

This impedance is defined as:

$$Z_{posmem} = \frac{V_{posmem}}{I_{pos}}$$

where $V_{pos\ mem}$ is the memorized positive sequence voltage calculated from the polarization voltage signals, Figure 4.5: Effect of the Ring Filter on page 4-9, and I_{pos} is the positive sequence line current.

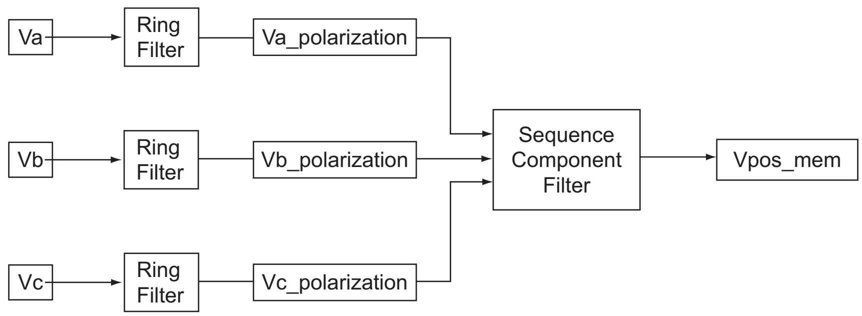


Figure 4.4: Vpos_mem Calculation

The effect of the Ring Filter (implemented in software) is to retain voltage information even if the voltage is severely depressed by a fault.

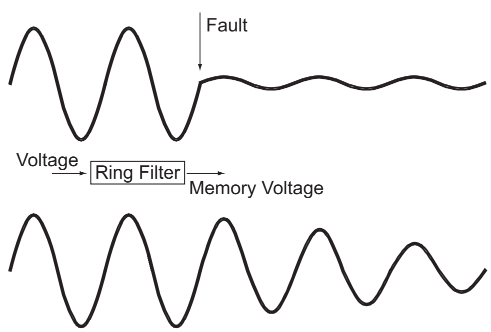


Figure 4.5: Effect of the Ring Filter

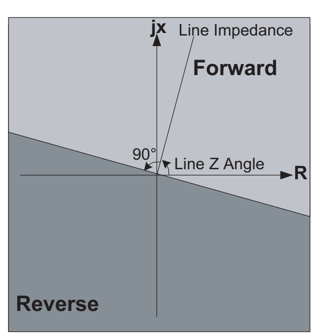


Figure 4.6: Directional Element

The principle of the directional element is shown above. If $Z_{pos\ mem}$ falls into the light gray area, Forward, it indicates a forward fault; and if it falls into the dark gray, Reverse area, a reverse fault is declared.

This directional element is used for directional overcurrent protection. No user settings are needed for this function.

Directional Control for Overcurrent Functions in F-PRO

The positive sequence memory voltage is also used to provide directional control to the overcurrent functions within the F-PRO relay. In this case, the positive sequence memory voltage and the positive sequence line current difference angles are compared to determine the directionality. For example, if the relay is set to directional mode, it allows the overcurrent function to operate if fault currents are towards the line and directions within 90 degrees of the line angle. For details see Figure 4.6: Directional Element on page 4-9.

For the directional control used on the overcurrent relays, a 30 cycle memory action is used on the positive sequence voltage. This memory action takes place only if a fault causes the positive sequence memory voltage to be above 2 volts secondary within the relay. If the positive sequence memory voltage goes below 2 volts, the directional control of the overcurrent reverts to a non directional characteristic, allowing it to operate and trip. For system faults that are not bolted three-phase faults that cause all phase-to-neutral voltages to go to zero, directional control are maintained because the positive sequence voltage does not go to zero.

25/27/59 Sync Check

The relay can bring in voltages from both line and bus PTs. The Sync Check function, if enabled, looks at the voltage steady state angle between the bus and the line PT voltage. If this angle is within a plus/minus specified value, (+/- 1 to 50 degree magnitude range of setting available), the function enables a definite time delay pickup (user-selectable 0 to 99.99 seconds) after which time an output is produced. The line sync reference voltage is taken from a bus and/or a line source; F-PRO uses one single-phase-to-neutral voltage. Settings within the relay allow the single-phase quantity to be offset from Phase A of the line PT by 0 to 330 degrees in 30 degree increments. The Dead Main Live Sync, Live Main Dead Sync and Dead Main Dead Sync logic functions can use fixed values of main and sync positive secondary voltages to determine the sync check condition. The voltage is fixed at 20 volts secondary, voltages below 20 volts are declared a dead state and voltages above 20 volts are declared a live state.

When enabled, this function checks that the voltage angle between the Main ac volts PT and bus sync ac volts PT voltages are within a specified value. Use this function to ensure that closing a line to a system results in acceptable power flow. The function uses three voltages from the Main PT and a single voltage from the Sync PT to make the angle measurement.

The dead main dead sync logic is based on fixed voltages less than 20 volt seconds. i.e. The line or bus is declared dead if its voltage is less than that value. The Sync PT Phase is settable in System Parameters from 0 to 330 degrees in steps of 30 degrees.

Table 4.8: 25/27/59 Sync Check	
25 Sync Check	Enable/disable
Maximum Voltage	60.0 to 138.0 volts secondary
Minimum Voltage	40.0 to 115.0 V secondary If Maximum Voltage ≤ 115 40.0 V ≤ Minimum Voltage Setting ≤ Maximum Voltage Setting -0.1 else 40.0 ≤ Minimum Voltage ≤ 115
Angle Difference	1.0 to 50.0 degrees
Pickup Delay	0.00 to 99.99 seconds
Main/Aux	
Dead Main Live Sync (DMLS) Enabled	Enable/disable
Live Main Dead Sync (LMDS) Enabled	Enable/disable
Dead Main Dead Sync (DMDS) Enabled	Enable/disable

79Main/79Aux Recloser

F-PRO includes a four shots recloser with sync check supervision. After four tries, the recloser is locked out until the feeder returns to normal by manual operation. i.e. The feeder has been on with a load greater than the low set setting for a certain amount of time.

79Main and 79Aux are identical except the inputs are different. For device 79 initiate and block functions are defined in the output matrix.

Ring bus applications provide two separate reclosers.

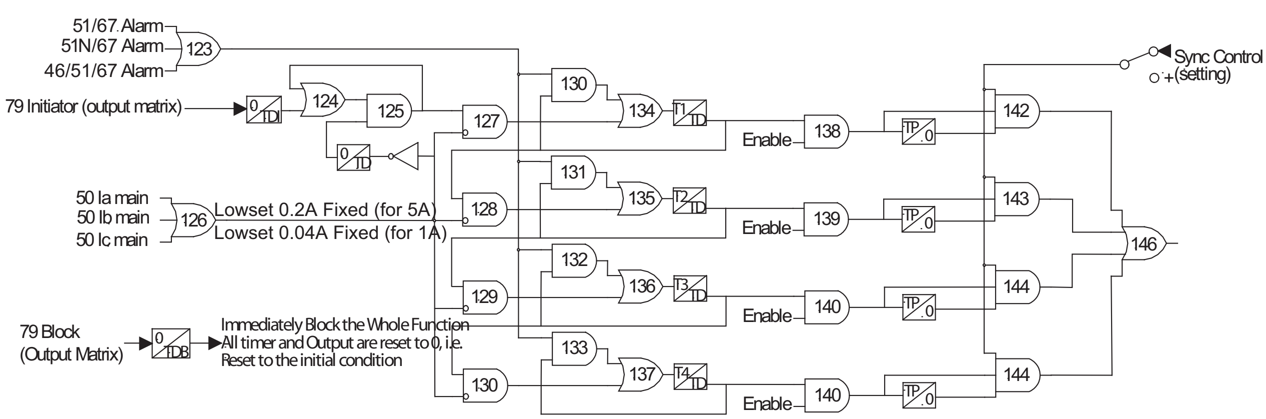


Figure 4.7: 79 Main Recloser

Table 4.9: 79 Recloser	
79 Recloser	Enable/disable
Number of Shots	1 to 4
First Reclose (T1)	0.02 to 999.99 seconds
Second Reclose (T2)	1.00 to 999.99 seconds
Third Reclose (T3)	1.00 to 999.99 seconds
Fourth Reclose (T4)	1.00 to 999.99 seconds
Close Time (Tp)	0.01 to 1.00 seconds
Lockout Reset (TD)	0.00 to 999.99 seconds
Initiate Reset (TDI)	0.00 to 999.99 seconds
Block Reset (TDB)	0.00 to 999.99 seconds
Sync Control Enabled	Enable/disable

59 Overvoltage

The F-PRO has a definite time delay main overvoltage function. This function looks at all three phase-to-neutral voltages to determine an overvoltage condition. The logic gate can be set to either AND or OR gate to detect all 3 phase or any phase (of the 3 phases) overvoltage conditions. The definite time delay can be set to 0.0 for a instantaneous trip.

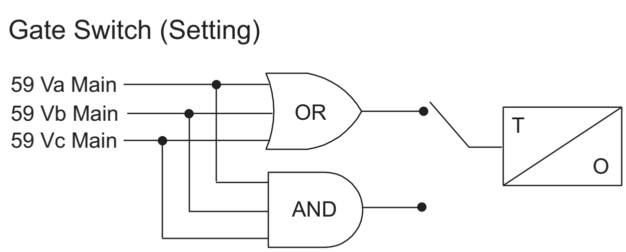


Figure 4.8: 59 Overvoltage

Table 4.10: 59 Overvoltage	
59-1	Enable/disable
Gate Switch	AND or OR
Pickup	1.0 to 138.0 volts
Pickup Delay	0.00 to 99.99 seconds
59-2	Enable/disable

Table 4.10: 59 Overvoltage	
Gate Switch	AND or OR
Pickup	1.0 to 138.0 volts
Pickup Delay	0.00 to 99.99 seconds

27 Undervoltage

The F-PRO has a definite time Delay main undervoltage function. The function looks at the phase-to-neutral voltage of all three phases to make a determination of an undervoltage condition. The logic gate can be set to either AND or OR gate to detect all 3 phase or any phase (of the 3 phases) undervoltage conditions. The definite time delay can be set to 0.0 for a instantaneous trip.

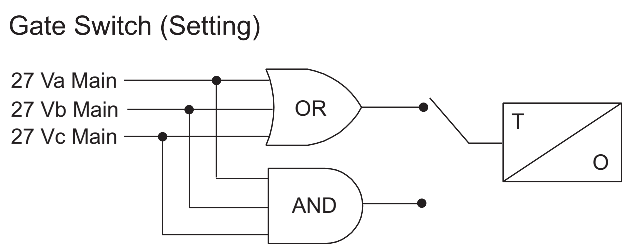


Figure 4.9: 27 Undervoltage

Table 4.11: 27 Undervoltage	
27-1	Enable/disable
Gate Switch	AND or OR
Pickup	1.0 to 120.0 volts
Pickup Delay	0.00 to 99.99 seconds
27-2	Enable/disable
Gate Switch	AND or OR
Pickup	1.0 to 120.0 volts
Pickup Delay	0.00 to 99.99 seconds

60 Loss of Potential

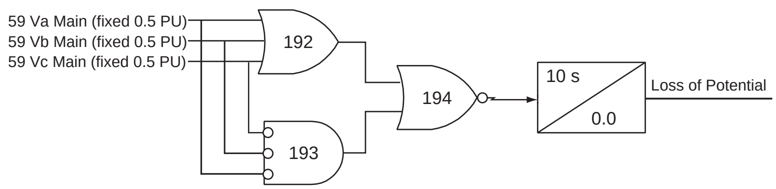


Figure 4.10: 60 Loss of Potential

This function detects the loss of potential from either one or two phases of a PT and issues an alarm.

Table 4.12: 60 Loss of Potential	
60 Loss of Potential	Enable/disable
Pickup Delay	10.00 seconds fixed

81 Frequency

The relay has four frequency devices available. Each frequency element can be set to operate either at a fixed level of under-frequency, a fixed level of over-frequency or at a rate of change level (df/dt). The df/dt function can be set to operate for a positive rate of change or a negative rate of change. Each frequency element has a definite time delay setting to create a time delayed output. A fixed level of positive sequence voltage of 0.25 pu or 5 volts whichever is greater provides an undervoltage inhibit on each element.

Four frequency elements are provided, settable from over/under frequency, fixed level to rate of change.

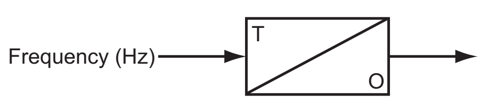


Figure 4.11: Frequency Fixed Level

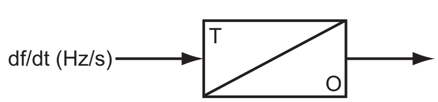


Figure 4.12: Frequency Rate of Change

Table 4.13: 81 Over/Under Frequency	
81-1	Disabled/Fixed Level/Rate of Change
Pickup	50.000 to 59.995 Hz OR 60.005 to 70.000 Hz for 60 Hz (Fixed Level) 40.000 to 49.995 Hz OR 50.005 to 60Hz for 50 Hz (Fixed Level) -10.0 to -0.1Hz/s OR 0.1 to 10.0 Hz /s for 50 & 60 Hz (Rate of Change)
Pickup Delay	0.05 to 99.99 seconds (Fixed Level) 0.10 to 99.99 seconds (Rate of Change)
81-2	Disabled/Fixed Level/Rate of Change
Pickup	50.000 to 59.995 Hz OR 60.005 to 70.000 Hz for 60 Hz (Fixed Level) 40.000 to 49.995 Hz OR 50.005 to 60Hz for 50 Hz (Fixed Level) -10.0 to -0.1Hz/s OR 0.1 to 10.0 Hz /s for 50 & 60 Hz (Rate of Change)
Pickup Delay	0.05 to 99.99 seconds (Fixed Level) 0.10 to 99.99 seconds (Rate of Change)
81-3	Disabled/Fixed Level/Rate of Change
Pickup	50.000 to 59.995 Hz OR 60.005 to 70.000 Hz for 60 Hz (Fixed Level) 40.000 to 49.995 Hz OR 50.005 to 60Hz for 50 Hz (Fixed Level) -10.0 to -0.1Hz/s OR 0.1 to 10.0 Hz /s for 50 & 60 Hz (Rate of Change)
Pickup Delay	0.05 to 99.99 seconds (Fixed Level) 0.10 to 99.99 seconds (Rate of Change)
81-4	Disabled/Fixed Level/Rate of Change
Pickup	50.000 to 59.995 Hz OR 60.005 to 70.000 Hz for 60 Hz (Fixed Level) 40.000 to 49.995 Hz OR 50.005 to 60Hz for 50 Hz (Fixed Level) -10.0 to -0.1Hz/s OR 0.1 to 10.0 Hz /s for 50 & 60 Hz (Rate of Change)
Pickup Delay	0.05 to 99.99 seconds (Fixed Level) 0.10 to 99.99 seconds (Rate of Change)

32P/32Q Directional Power

F-PRO provides directional real power and reactive power protection. Set the pickup setting to a positive value (trip on forward power flow away from bus) or a negative value (trip on reverse power flow into bus).

You can set either a real (32P) and a reactive (32Q) direction. The values are set by specifying the pickup current. This value is set to positive values to detect power flow from the bus and to negative values to detect power flow into the bus.

Table 4.14: 32 Directional Power	
32P	Enable/Disable
Real Current (3 phase) Pickup	±0.25 to ±15.0 A for 5 A ±0.05 to ±3.0 A for 1 A
Pickup Delay	0.00 to 99.99 s
32Q	Enable/Disable
Reactive Current (3 phase) Pickup	±0.25 to ±15.0 A for 5 A ±0.05 to ±3.0 A for 1 A
Pickup Delay	0.00 to 99.99 s

21P Phase Distance

The relay has two mho phase distance elements. Each element includes a forward reach and delta current supervisor setting. The element output is only available as a ProLogic.

Table 4.15: 21 Phase Distance	
21P1	1-Enabled or 0-Disabled
Forward Reach	0.05 to 66.00 Ohms for 5 A 0.25 to 330 Ohms for 1 A
Delta Current Supervision	0.20 to 50.00 amps for 5 A 0.04 to 10 amps for 1 A
21P2	1-Enabled or 0-Disabled
Forward Reach	0.05 to 66.00 Ohms for 5 A 0.25 to 330 Ohms for 1 A
Delta Current Supervision	0.20 to 50.00 amps for 5 A 0.04 to 10 amps for 1 A

THD Alarm

This function checks and picks the highest THD in any of the six current inputs (if ring bus configuration is enabled). It only checks the three main current inputs for highest THD, if ring bus configuration is disabled.

Table 4.16: THD Alarm	
THD Alarm	Enable/disable
Pickup	5.0 to 100.0%

Fault Locator

When a fault occurs and the line trips, the fault locator calculates the fault type and the distance to the fault. This information is available from the front display of the relay or through terminal UI, or SCADA. Enable or disable the fault locator through 50/67, 51/67, 50N/67, 51N/67, 46-50/67, 46-51/67, 50G1/67, 50G2/67 and 51G/67 respectively. Define the functions initiating the fault location when setting.

ProLogic

ProLogic Control Statements

Using ProLogic, F-PRO can pick any of the protection functions or external inputs and place them into Boolean-like statements. ProLogic handles up to five functions to generate one ProLogic statement; ten statements are possible. The results from these statements are mapped to output contacts using the output matrix.

Special ProLogic inputs are:

- Output relay #12 as an input to ProLogic.

The ProLogic control statements are used to create Boolean-like logic. The F-PRO can use any of the protection functions or external inputs combined with logic gates to create a ProLogic control statement. The possible gates are AND, NAND, OR, NOR, XOR, NXOR, and LATCH. The control can be time delay pickup and or time delay dropout, and can drive the front panel target LED. Ten ProLogic control statements outputs are available and can be used in the output matrix to customize the relay to your specific needs. Inputs to ProLogic are all the elements plus previous ProLogic statements for logic nesting usage.

The example shows A to E inputs are status points of devices that are user-selectable. Each ProLogic output can be given a specific name, pickup and reset time delay.

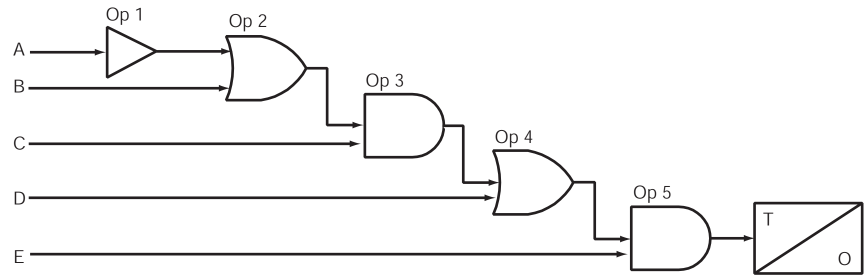


Figure 4.13: ProLogic

Table 4.17: ProLogic Setting Functions	
Name	Give the ProLogic a meaningful name
Pickup Delay	Delay time from pickup to operate (0.00 to 999.00 seconds)
Dropout Delay	Delay time from dropout to a ProLogic status of low (0.00 to 999.00 seconds)
A, B, C, D, E	Relay elements as input statements
Operators	Boolean-type logic gates

Breaker Monitoring

The F-PRO breaker monitoring feature allows you to monitor the feeder breaker(s) in detail. An accumulated I*I*t function and ten user-definable logic statements can be used to determine the status of breaker wear and breaker performance.

Breaker monitoring can be configured for measuring the clearing time, mechanism time, trip coil energized time, operations count, fault operations or other user-defined conditions. Different users may require different feature sets to monitor the breaker. The breaker monitoring functions are realized through the Breaker Logic functions.

All associated breaker monitoring values are available in the terminal UI and SCADA interfaces. You can reset or preset all associated breaker monitoring values from the terminal UI interface. You can only reset all associated breaker monitoring values from the terminal SCADA interfaces.

Breaker Logic

The Breaker Logic function is similar to a ProLogic function, but includes some additional features specifically for breaker monitoring allowing different users to design their own breaker monitoring features by building different breaker logic statements. Breaker Logic has additional timers on every output of the logic statement, a total of four timers are available; a counter (including settable count limit) is available in the last logic gate position. The front panel target LED is configurable and the logged message can be configured either when one of the four timers has expired or when the counter limit has been exceeded. A total of 10 Breaker Logic functions are available in the F-PRO.

The terminal UI and SCADA interfaces shows the status of each breaker logic and associated counter. The terminal UI also includes the time of last reset/preset.

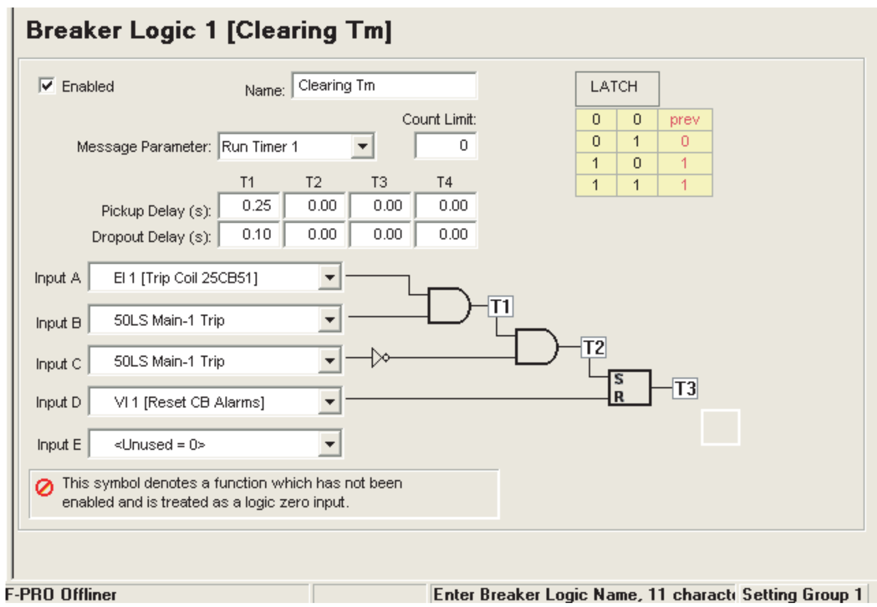


Figure 4.14: Breaker Logic

For examples of breaker condition monitoring using Breaker Logic see “Setting Examples” in Appendix L.

I*I*t

F-PRO has an accumulated I^2t function used for monitoring the wear of the breaker due to fault interruption. This function is available for both the main breaker and the auxiliary breaker. The I^2t value is accumulated for every operation and stored in the non-volatile memory; the write time interval will be 0.5 seconds. A fixed maximum write time of 20 seconds prevents the I^2t function from constantly writing to non-volatile memory. Therefore if the start signal is held on for longer than 20 seconds the accumulator will stop accumulating and stop writing to the flash memory. The output I^2t function will only be available in the event log, the output is not available in the output matrix or in the ProLogic input list.

The terminal UI and SCADA interfaces will show the accumulated value of each breaker I^2t function and value of last operation. The terminal UI will also include the time of last reset/preset.

The following figure shows the I^2t function's logic diagram. The accumulation is started when the trip coil of the breaker is energized (breaker starts to open), and will be stopped when the trip coil of the breaker is de-energized. The current that is used for accumulation is the maximum current among Phase A, B and C. An event message will be generated when the accumulated I^2t value is above the limit.

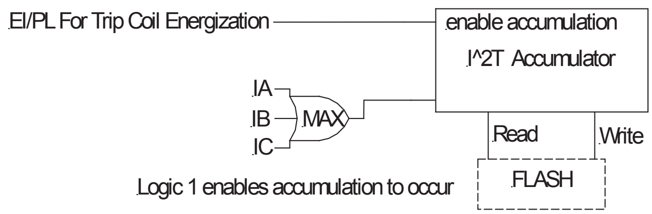


Figure 4.15: I*I*t

4.2 Demand/Trend Metering

The F-PRO has a demand metering feature which calculates the following quantities:

- 3 phase real power IN (MW)
- 3 phase real power OUT (MW)
- 3 phase reactive power IN (MVAR)
- 3 phase reactive power OUT (MVAR)
- Line Current IA (A Pri)
- Line Current IB (A Pri)
- Line Current IC (A Pri)
- Main Voltage A (kV Pri)
- Main Voltage B (kV Pri)
- Main Voltage C (kV Pri)
- Frequency (in Hz)
- THD (in%)

You can select from three calculation types, integrating, rolling and thermal. They are described in detail below.

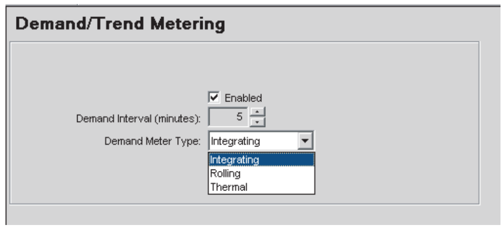


Figure 4.16: Integrating Demand Meter

Integrating demand meter is a linear average of the quantity over the demand interval. Each new value only becomes available at the end of each time interval. The average is calculated from samples taken every 0.5 seconds during the demand interval. Therefore, the equation for calculating what the demand quantity will be is based on the following equation:

New demand value = Sum of the samples during the demand interval / (120*Demand Interval Setting)

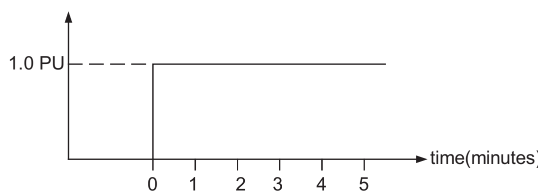


Figure 4.17: Step Power Input

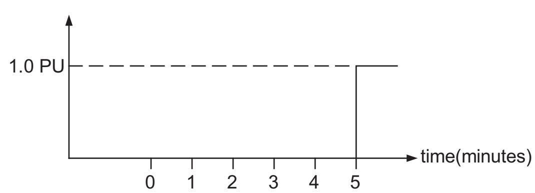


Figure 4.18: Integrating Demand Meter

Figure 4.17: Step Power Input on page 4-21 shows the input signal, which is a magnitude of zero and then suddenly goes to an instantaneous level of 1.0 per unit, i.e. a step change function.

Figure 4.18: Integrating Demand Meter on page 4-21 shows the integrating demand meter, i.e. the demand value will not be calculated or updated until the end of the demand interval (setting, it's 5 minutes for this example). The response for integrating demand meter is shown in the following table:

Table 4.18: Integrating Demand Meter

Time (min.)	1	2	3	4	5	6

Table 4.18: Integrating Demand Meter						
Demand (% of Input)	0	0	0	0	100	100

Rolling Demand Meter

Rolling demand, also called “sliding window”, is a process by which intervals are divided into a fixed number of subintervals. Instead of calculating demand only at the end of each interval, the calculation is performed at the end of each subinterval, and totaled and averaged for the interval. The subinterval is 1 minute (fixed) in F-PRO relay. The calculation is the same as the Integrating Demand Meter.

Figure 4.19: Rolling Demand Meter on page 4-22 shows the rolling demand meter response to the input of Figure 4.17: Step Power Input on page 4-21. The demand value is calculated and updated on each subinterval (one minute). The average calculation is performed over the demand internal (setting, equal 5 minutes for this example). The response to the input shown in figure 1 for rolling demand meter is shown in the following table:

Table 4.19: Rolling Demand Meter						
Time (min.)	1	2	3	4	5	6
Demand (% of Input)	20	40	60	80	100	100

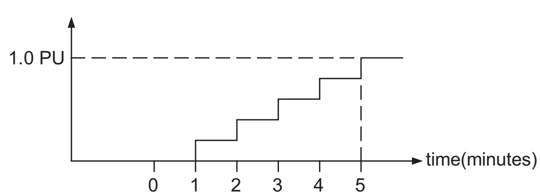


Figure 4.19: Rolling Demand Meter

Thermal Demand Meter

The thermal demand meter is described in this section. Again, use the step change power input from Figure 4.17: Step Power Input on page 4-21 as an example.

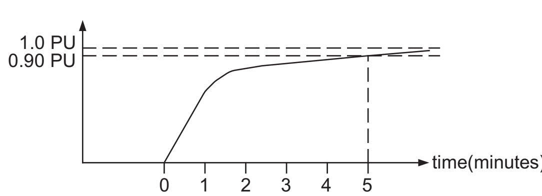


Figure 4.20: Thermal Demand

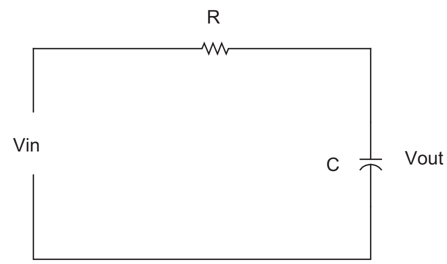


Figure 4.21: RC Circuit

Figure 4.20: Thermal Demand on page 4-22 shows the thermal model of demand calculation. It acts like a RC circuit as shown in Figure 4.21: RC Circuit on page 4-23. The output voltage will never reach the final value until the time goes to infinity, however, we define it in this way it will reach the 90% of the input when the elapsed time is equal to the Demand Interval (5 minutes for this example). The thermal demand will reach 99% of the input when the time is twice of the demand interval, as shown in the table below. The equation for this response is Vout = Vin*(1-e-t/τ), where τ is the time constant and it is equal to 2.17147241 minutes. The thermal demand meter data will be calculated and updated every half-second. The following table shows the response of the thermal demand.

Table 4.20: Thermal Demand Meter

Time (min.)	1	2	3	4	5	6	7	8	9
Demand (% of Input)	36.9	60.1	74.8	84.1	90	93.6	96	97.4	98.4

4.3 Accumulated Energy (kWh, kVARh metering)

For the accuracy and the consistency, the method of the energy calculation is the same regardless of the demand type. (rolling, integration, thermal). There are four accumulated energy quantities. They are:

- 3 Phase real energy OUT (MWh)
- 3 Phase real energy IN (MWh)
- 3 Phase reactive energy OUT (MVARh)
- 3 Phase reactive energy IN (MVARh)

The accumulated energy quantities are calculated by the integration of the average power over the elapsed time. This calculation is carried out once per minute, however the actual power is sampled every half second and averaged every minute (120 samples).

The accumulated energy quantities are stored in the non-volatile memory to avoid the data loss on power down.

When the accumulated energy quantities exceed 98000 MWh/MVARh they are reset to zero. A reset on one energy quantity will only reset it's own value, not the other energy quantities. All reset actions will be logged in the event log.

Group Logic

Group Logic Control Statements

The F-PRO relay has eight setting groups (SG). The user can change all relay setting parameters except the physical connections such as input or output parameters in each setting group. Setting group changes are performed by using any one of the 16 available Group Logic statements per setting group. The Group Logic statements are similar to the ProLogic statements with the following exceptions — the sole function is to activate one of the eight setting groups and the processing is in a slower half second cycle. Group Logic input statements are driven from ProLogic, any external input, previous Group Logic statements or virtual inputs. Each Group Logic statement includes five inputs (with Boolean statements), one latch state and one pickup delay timer. The active setting group (ASG) is viewed using the Relay Control Panel, the front panel or from a record stored by the relay (the active setting group is stored with the record).

Group Logic Processing

The sixteen Group Logic statements reside in a slower processing thread within the relay protection algorithms. The processing cycle happens once every half second (0.5 second). When using ProLogic statements remember that a latch or dropout timer should be used if the initiating condition does not last at least 0.5 seconds. In the example following, we will create a definite pulse length using ProLogic. For details see “F-PRO Setting Example” in Appendix L.

Default Setting Group

The relay uses Setting Group 1 as the factory default setting group and retains the current active setting group in memory. This allows the relay to use the last active setting group prior to interruption of relay power as the default setting group following power up.

Change Active Group

The user can at any time change the active setting group. When you initiate a setting group change, this change takes precedence over an automatic setting group change. The setting group can be changed using the Relay Control Panel, with either Change or Service access level, using the following path:

Relay Control Panel > Utilities > Settings Group

In this tab, choose desired setting group number and hit *Save*.

The setting group can also be changed using the relay display interface, after login in with the Change or Service access level, using the following path:

Main Menu > Utilities > Maintenance > Settings Group Control

In this screen, highlight the group number, and then hit Edit. Choose the desired setting group number, and then hit Enter with the cursor in the return character (bottom right).

Settings Saved

You can change the active setting group while saving setting changes or loading settings from Offliner. The relay prompts you for a setting group to activate— you can keep the current setting group or switch to a new setting group following the settings save.

Manual Settings Change

Relay configuration changes during a user-initiated manual setting; the change does not disrupt the relay protection functions. The relay logs an acceptance of the change request and puts the new setting file in service. When the new setting file is queued the relay loads the new setting configuration for protection functions to the protection processor. The relay loads the new name definitions for indication and recording functions to the interface processor. When the relay has completed loading the ancillary settings for indication purposes to the interface processor, an event is logged to show completion of the request. There is some lag time during the load request and the completion of the request where the interface processor associates ancillary functions with the previous setting file for approximately five seconds. The ancillary setting information includes channel or ProLogic and Group Logic statements names, front panel target light activation rules and record initiation rules.

The protection processor does not have any interruption in service.

Automatic Settings Change

Relay configuration changes during a relay-initiated setting; change does not disrupt the relay protection functions. Since the relay setting file does not change, the interface processor uses the new setting group ancillary setting information at the same time as the protection processor switches to the new setting group. An event is logged to show when the new setting group is in service.

4.4 Recording Functions

The F-PRO Relay provides numerous recording and logging functions, including a fault recorder, a trend log and an event log to analyze faults, to know the performance of the relay and to observe the status of the protection scheme. and to review the operation of the overall protection scheme.

Fault Recording

The F-PRO provides high quality fault recording, capturing input signal waveforms and external digital input states at a rate of 96 samples per cycle. Each record also contains the timing of the internal logic produced by the relay (e.g. 51 trip).

The quantities recorded are:

- 11 analog channels: 4 voltages and 7 currents @ 96 samples/cycle, up to the 25th harmonic frequency
- 9 external digital inputs: @ 96 samples/cycle
- relay internal logic signals: @ 8 samples/cycle
- summation channel, @ 96 samples/cycle, up to the 25th harmonic frequency
- 30 Virtual Inputs, 8 samples/cycle
- 10 ProLogic signals, 8 samples/cycle.

Trend Recording

The trend recording provides continuous, slow-speed recording of P, Q, Energy, V, I, Freq. and THD of the feeder with an adjustable sample period from 5 to 60 minutes per sample. This same global trend sampling rate is applied to all the trend quantities. The relay stores a fixed number of samples. At the nominal sample period of 5 minutes per sample the F-PRO stores one month of trend records with automatic overwrite of the oldest.

Table 4.21: Trend Record

Sample Interval	Trend Record Length
5 minute	30 days
10 minute	60 days
30 minute	180 days
60 minute	360 days

Record Initiation

Recording can be initiated automatically by the relay when a fault or abnormal condition is detected. You can set the relay to initiate a fault record upon activation of any of its trip or alarm functions or on assertion of any external digital inputs.

The assignment of fault record initiation to the various relay functions is done through the relay's Output Matrix settings.

A recording can also be initiated manually through the Relay Control Panel interface in the *Records* tab

Record Duration and Extension

The length of each record is determined by the Record Length setting. Fault record lengths can be set between 0.2 and 2.0 seconds. Pre-trigger times are fixed at 10 cycles for fault records and are included as part of the normal record length. A trend recording is for a 30 day period at one sample/5 minutes. A trend recording can also be initiated manually through the Relay Control Panel. The command *Trigger Trend* is available under the *Records* menu.

The F-PRO automatically extends a record as required to capture consecutive triggers that are close together. If a trigger occurs while a recording is in progress, the record is stretched to include the full post-trigger time of subsequent triggers, up to a maximum length — 2.0 seconds for fault records. If a trigger occurs before the end of a record caused by a previous trigger, but too late to allow sufficient post-trigger time in a maximum extended record, a new overlapping record is created.

The normal record lengths settings are accessible in the *Settings>Record Length* option settings, and can be set from either the HMI or the Offliner Settings software.

Event Recording

The event recording provides permanent storage of the event log. An event record can be created automatically or manually. When the event auto save is enabled an event record is created approximately every 230 events.

A recording can also be initiated manually through the HMI or Relay Control Panel. The command *Trigger Event* is available under the *Records* menu.

Record Storage

The F-PRO compresses records on the fly, achieving a typical lossless compression rate of 4:1. As a result, the F-PRO can store up to 150 seconds of fault recordings and a minimum of 30 days of trend recordings in non-volatile storage. If the storage is full, new records automatically overwrite the oldest, ensuring that the recording function is always available.

Retrieval and Analysis

A list of stored records is available through the Relay Control Panel in the *Records* tab. From Relay Control Panel you can retrieve the record and delete or leave on the relay, graph the record, export the record to COMTRADE. Records are named by combining the Unit ID setting with the date and time of the initiating record trigger.

To delete a record from storage, right-click on the record and select *Delete*, or alternatively, select the record and press the <*Del*> key. You can also do group deleting and group transferring.

To select multiple records:

1 Select a record.
2. Hold the <*Shift*> key.
3. Continue selecting records until all desired records are selected.
4. Press the <Del> key. A message asks “Are you sure you want to delete multiple records from the relay?” shown above. Select *Delete* and the files are deleted.

When a record is retrieved from the relay using Relay Control Panel program, it is automatically transferred to your PC as well. The record is placed in your Relay Control Panel program’s *Recordings folder*. The Relay Control Panel's default *Recordings folder* can be set when the relay is initially connected to the PC, as shown in the following image.

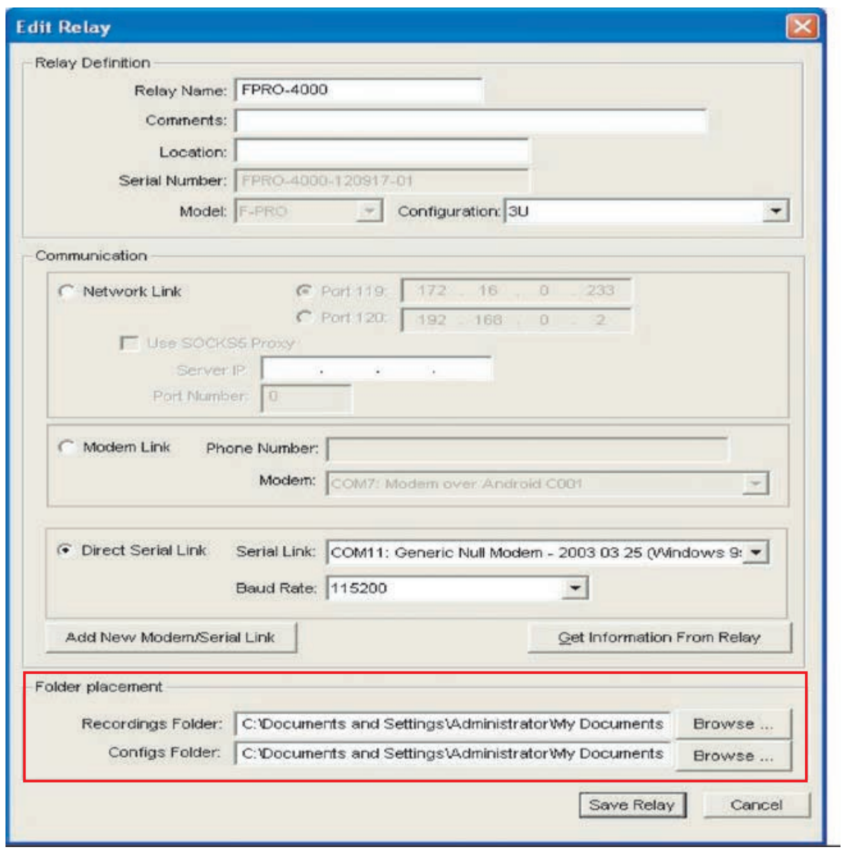


Figure 4.22: Recording Folder

When transferred to your computer, the record name remains unchanged and the file extension indicates the record type: .fpr for transient recording, .fpt for a trend recording, .fpe for an event recording.

4.5 Logging Functions

Event Log

The F-PRO maintains a log of events in a 250 entry circular log. Each entry contains the time of the event plus an event description.

Logged events include trips, alarms, external input assertions plus internal events such as setting changes. Fault location and classification information is included in event messages where appropriate. For example, the event log entry for a device trip might be:

2000 Nov 21, 15:34:19.832 : 51 ABC 112.3 km: Trip.

The event log can be viewed in three ways:

- Relay Front HMI
- Relay Control Panel interface is in the *Events* tab
- SCADA protocols included in the F-PRO allow the SCADA master access to Trip and Alarm event data.

Events that occur during a transient fault recording are also embedded in the transient record and can be viewed in Relay Control Panel, RecordBase View and RecordGraph. Although the event log is circular, you may ensure events are not lost by checking the *Event Auto Save* box in the *Record Length* setting screen of F-PRO Offliner. When this option is selected, as the event log approaches 250 events, it will save the records to an event file .fpe. The event log will then be ready to capture up to 250 new events.

> This display is a snapshot of the event list which must be manually refreshed to display new events that occur while the display is up.

There is a list of the F-PRO event messages. For details see “Event Messages” in Appendix D.

Fault Log

The F-PRO stores a log of faults in a 100 entry circular log. Each entry contains the time of the fault, fault type, faulted phase, fault quantities as per the below table. Fault log will be triggered only for trip condition and it won't log for an alarm condition.

Table 4.22: Fault Log

Fault Type	Fault Quantities
50LS-1,2 Main	- Main I1A/I1B/I1C Phasors
50LS-1,2 Aux	- Aux I2A/I2B/I2C Phasors
59-1,2 27-1,2	- Main VA/VB/VC Phasors

Table 4.22: Fault Log

50 Trip 51 Trip	- Fault location - Phase Indication (digital indication of A/B/C phases) - Line IA/IB/IC Phasors - Main VA/VB/VC Phasors - Frequency
50N Trip 51N Trip	- Fault location - Line Current Zero Sequence Phasors (3I0) - Line IA/IB/IC Phasors - Main VA/VB/VC Phasors - Frequency
50G-1 Trip 50G-2 Trip 51G Trip	- Fault location - IG Ground Current Phasors - Line IA/IB/IC Phasors - Main VA/VB/VC Phasors - Frequency
46-50 Trip 46-51 Trip	- Fault location - Line Current Negative Sequence Phasors (3I2) - Line IA/IB/IC Phasors - Main VA/VB/VC Phasors - Frequency

The fault log can be viewed in three ways:

- Relay Front HMI
- Relay Control Panel interface is in the Events tab
- 61850 SCADA protocol included in the F-PRO allow the SCADA client access to Trip event data

5 Data Communications

5.1 Introduction

Section 5 deals with data communications with the relay. First, the SCADA protocol is discussed, and it is then followed by the new IEC 61850 communication standard.

The SCADA protocol deals with the Modbus and DNP (Distributed Network Protocol) protocols. The SCADA configuration and its settings are described. The parameters for SCADA communications are defined using F-PRO 4000 Offliner software. Finally, details on how to monitor SCADA communications are given for maintenance and trouble shooting of the relay.

5.2 SCADA Protocol

Modbus Protocol

The relay supports either a Modbus RTU or Modbus ASCII SCADA connection. Modbus is available exclusively via a direct serial link. Serial Modbus communications can be utilized exclusively via serial Port 122 are an RS-232 DCE DB9F port located on the back of the relay. An external RS-232 to RS-485 converter can be used to connect the relay to an RS-485 network. For details on connecting to serial Port, see “Communication Port Details” on page 2-15.

The data points available for Modbus SCADA interface are fixed and are not selectable by the user. Complete details regarding the Modbus protocol emulation and data point lists can be found in “Modbus RTU Communication Protocol” in Appendix E’ on page Appendix E-1.

DNP Protocol

The relay supports a DNP3 (Level 2) SCADA connection. DNP3 is available via a direct serial link or an Ethernet LAN connection using either TCP or UDP.

Serial DNP communications can be utilized exclusively via serial Port 122. Port 122 is an RS-232 DCE DB9F port located on the back of the relay. An external RS-232 to RS-485 converter can be used to connect the relay to an RS-485 network. For details on connecting to serial Port, see “Communicating with the Relay Intelligent Electronic Device (IED)” on page 2-2 and “Communication Port Details” on page 2-15.

Network DNP communications can be utilized via physical LAN Port 119 or Port 120. Port 119 is available as a pair of RJ-45 ports, one on the front of the relay and one on the rear. Port 120 is an ST fiber optic port located on the rear of the relay. DNP communications can be used with multiple masters when it is utilized with TCP. For details on connecting to the Ethernet LAN, see “Network Link” on page 2-5.

The data points available for DNP SCADA interface are user configurable. Complete details regarding the DNP3 protocol emulation and data point lists can be found in “DNP3 Device Profile” in Appendix F’ on page Appendix F-1.

SCADA Configuration and Settings

The parameters for SCADA communications may be defined using F-PRO 4000 Offliner.

If DNP3 LAN/WAN communications were chosen, the relay’s network parameters need to be defined. This is done via the Maintenance interface. Note that this effort may already have been completed as part of the steps taken to establish a network maintenance connection to the relay.

1. Establish a TUI session with the relay and login as **maintenance**. The following screen appears.

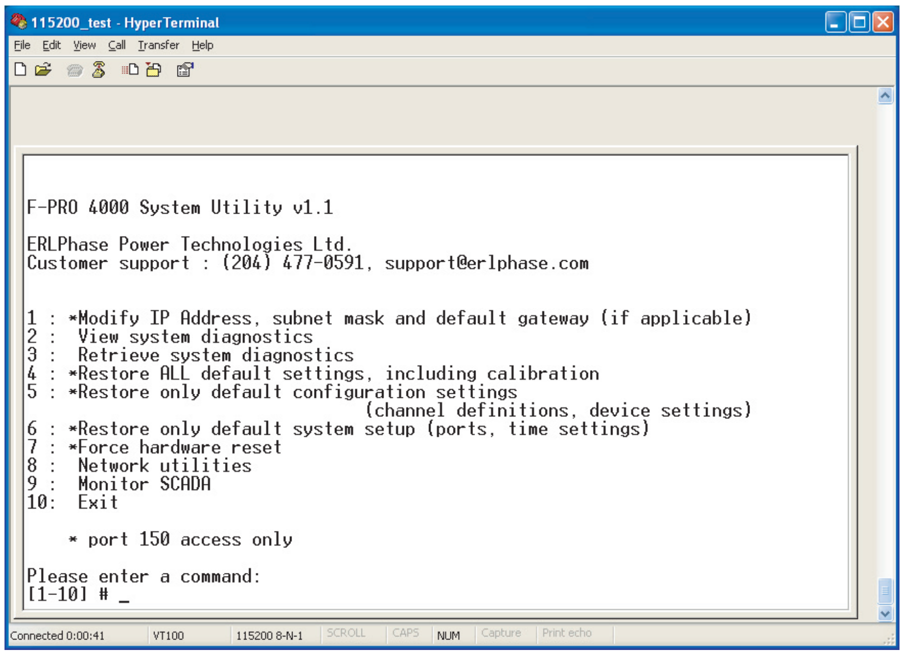


Figure 5.1: F-PRO 4000 System Utility

2. Select the first option by entering the number **1** followed by *Enter*. The following screen appears.

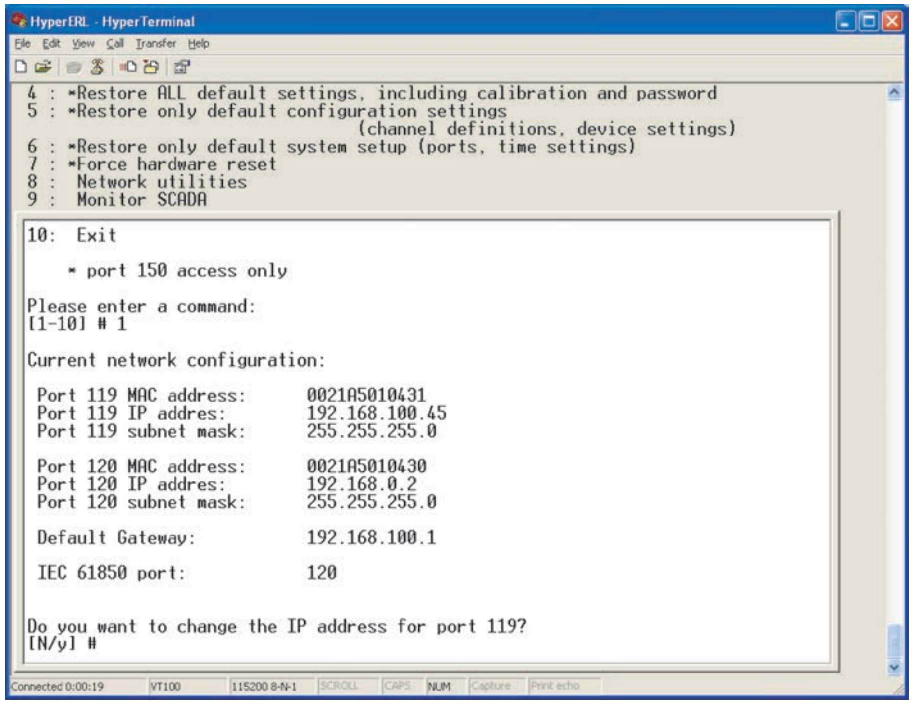


Figure 5.2: Change the network parameters as needed for the particular application

Offliner SCADA Configuration

Details on using the Offliner software are available in “To Install Software on the Computer” on page -xiii . Details on downloading a completed settings file to the relay are available in “Sending a New Setting File to the Relay” on page 6-6.

Open the Offliner application according to the instructions found in the indicated section and highlight the SCADA Communication selection. The screen appears as follows.

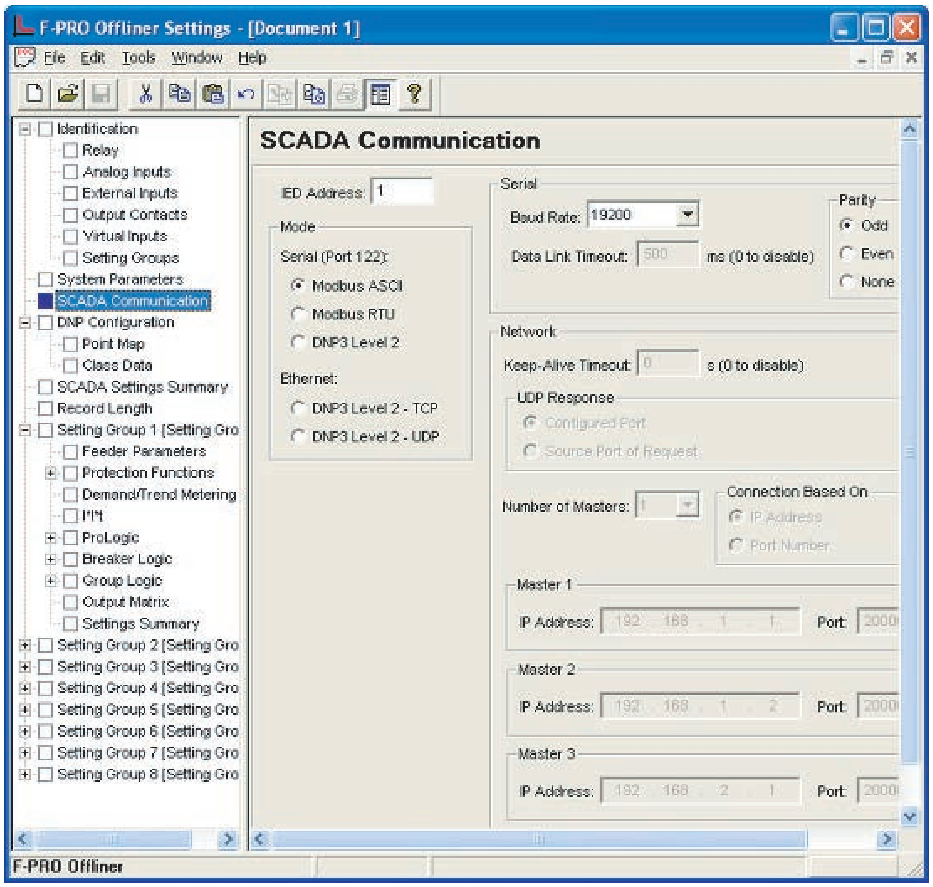


Figure 5.3: SCADA Communications

The configuration of SCADA communication parameters via the Offliner application is very intuitive. Several settings options are progressively visible and available depending on other selections. As noted before, there is no field to configure the number of data and stop bits. These values are fixed as follows:

- Modbus Serial – 7 data bits, 1 stop bit
- DNP Serial – 8 data bits, 1 stop bit

Monitoring SCADA Communications

The ability to monitor SCADA communications directly can be a valuable commissioning and troubleshooting tool. It assists in resolving SCADA communication difficulties such as incompatible baud rate or addressing. The utility is accessed through the Maintenance user interface.

1. Establish a TUI session with the relay and login as **maintenance**.
2. Select option 9 by entering the number **9** followed by *Enter*. The following screen appears.

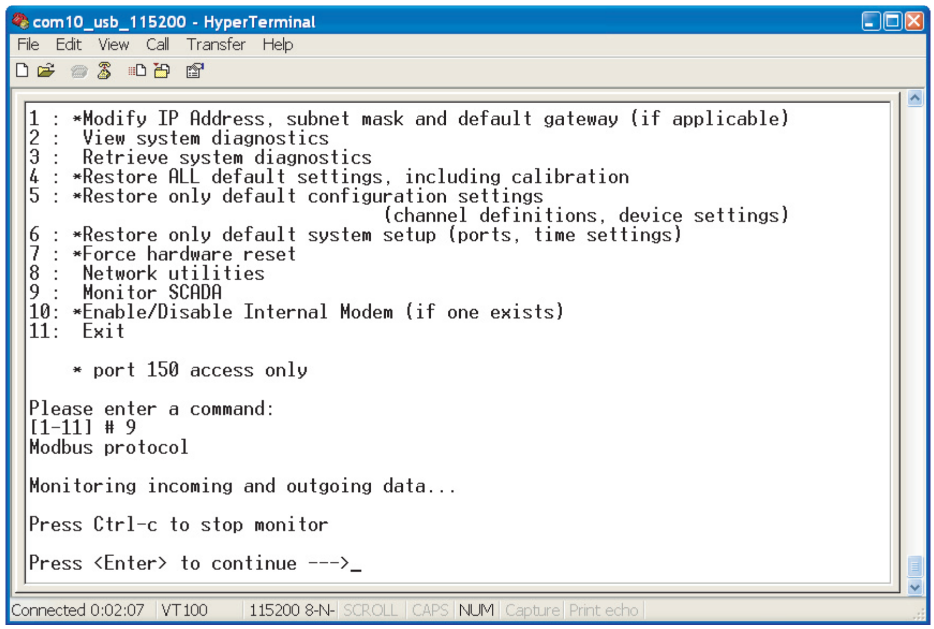


Figure 5.4: Login Screen

3. Pressing the *Enter* key results in all SCADA communications characters to be displayed as hexadecimal characters. Individual exchanges are separated by an asterisk as the following sample illustrates.

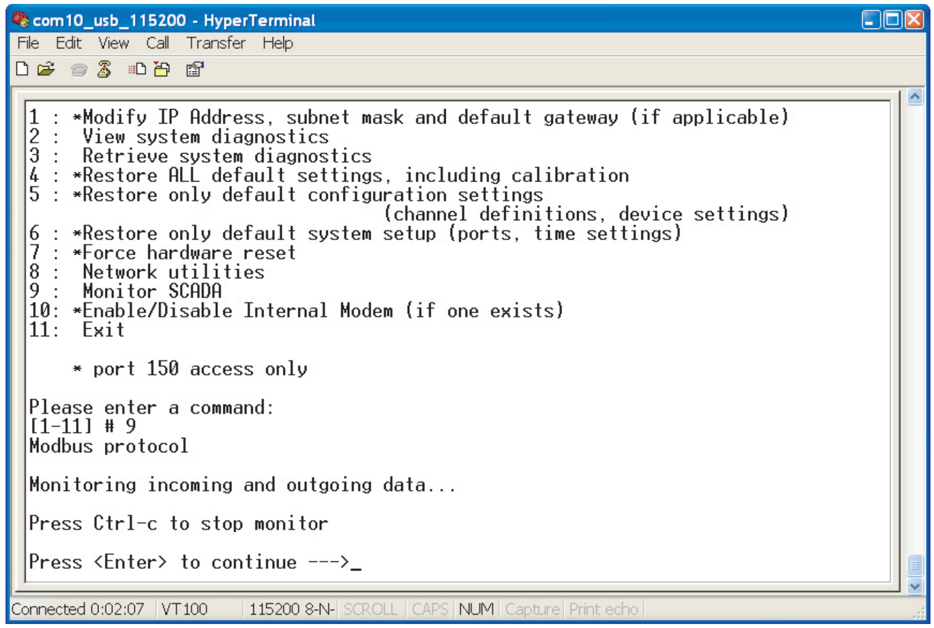


Figure 5.5: Hyperterminal

4. Press *Ctrl-C* to end the monitor session.

5.3 IEC 61850 Communication

The IEC 61850 Standard

The Smart Grid is transforming the electrical power industry by using digital technology to deliver electricity in a more intelligent, efficient and controlled way. Embedded control and communication devices are central to this transformation by adding intelligent automation to electrical networks.

The IEC 61850 standard defines a new protocol that permits substation equipment to communicate with each other. Like many other well-known manufacturers, ERLPhase Power Technologies is dedicated to using IEC 61850-based devices that can be used as part of an open and versatile communications network for substation automation.

The IEC 61850 defines an Ethernet-based protocol used in substations for data communication. Substations implement a number of controllers for protection, measurement, detection, alarms, and monitoring. System implementation is often slowed down by the fact that the controllers produced by different manufacturers are incompatible, since they do not support the same communication protocols. The problems associated with this incompatibility are quite serious, and result in increased costs for protocol integration and system maintenance.

Implementation Details

The F-PRO 4000 conforms to IEC 61850-8-1, commonly referred to as Station Bus Protocol. Implementation includes the following documents “IEC 61850 Implementation” in Appendix M’ on page Appendix M-1:

- Protocol Implementation Conformance Statement
- Model Implementation Conformance Statement
- Tissues Conformance Statement

All configurable IEC61850 parameters are available via the Maintenance interface. Note that this effort may already have been completed as part of the steps taken to establish a network maintenance connection to the relay.

1. Establish a TUI session with the relay and login as **maintenance**. The following screen appears.

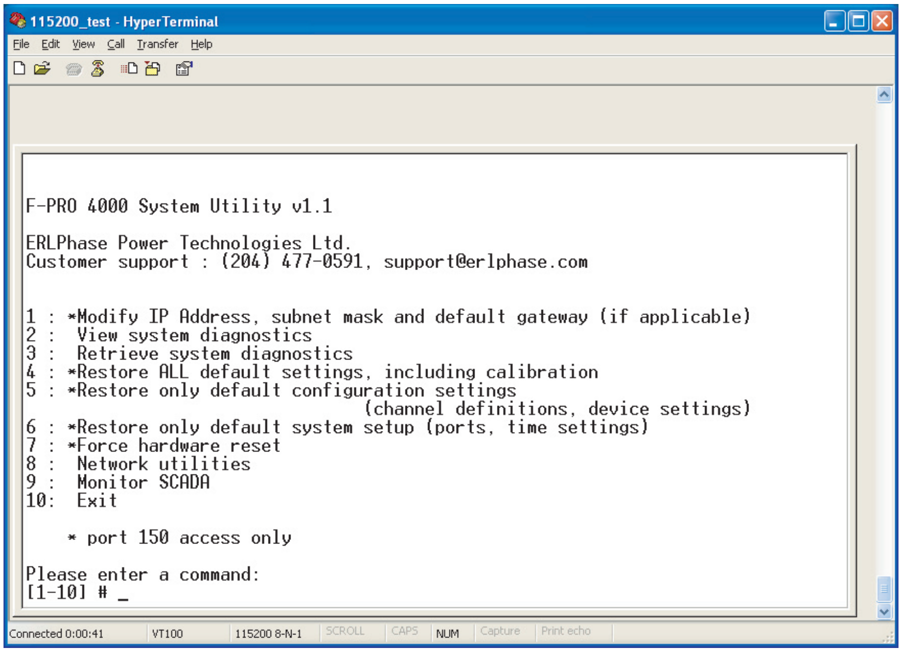


Figure 5.6: Maintenance Interface

2. Select the first option by entering the number **1** followed by <Enter>. The following screen appears.

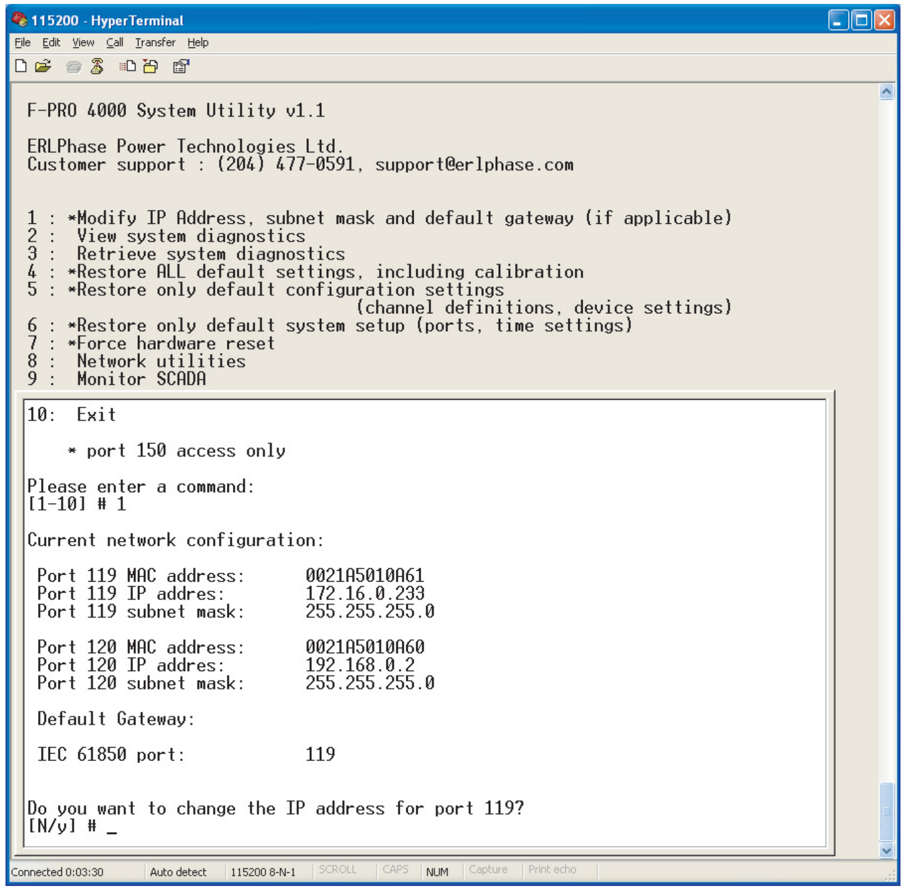


Figure 5.7: Change the network parameters as needed for the particular application

Note that unit's IP address can be used on the IEC61850 client side for unique unit identification instead of a physical device "PD Name". The publisher configuration is fixed and defined in the ICD file and available for reading to any IEC61850 client. Subscriber functionality is also fixed and supported for the Virtual Inputs only.

6 Offliner Settings Software

6.1 Introduction

This section deals with the Offliner Settings software. The Offliner settings software is used to create relay settings on a personal computer. Offliner provides an easy way to view and manipulate settings. Offliner supports all firmware versions and has the capability to convert older setting versions into newer ones.

In this section, first, the Offliner features are presented. The menu and tool bar are discussed and this is followed by a description of the Graphing and Protection functions.

Next, the Offliner features for handling backward compatibility with previous software versions is described. Also described are methods of converting a Settings File, sending a new Settings File to the relay and creating a Settings File from an older version of the software.

Next, the RecordBase View and RecordGraph to analyze the records from a relay are described.

This is followed by a lengthy description of the main branches from the Tree View. This section provides all information for Identification, System Parameters, SCADA Communication, DNP Configuration, SCADA Settings summary, Record Length, Setting Groups, ProLogic, Breaker Logic, Group Logic, Output Matrix and Settings summary.

Finally, a description of how the settings on the relay can be viewed through the RecordBase View analysis software is provided.

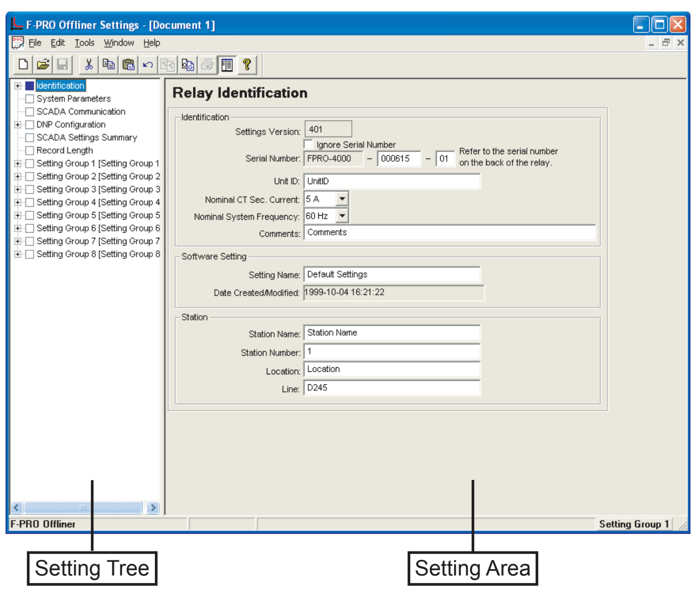


Figure 6.1: Opening Screen

6.2 Offliner Features

The Offliner software includes the following menu and system tool bar.

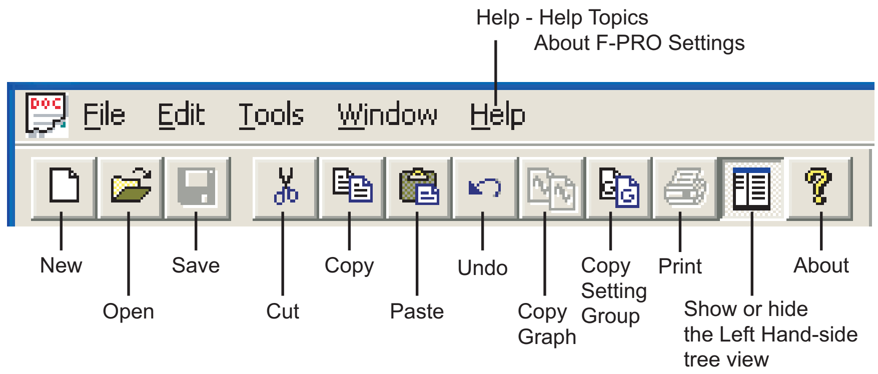


Figure 6.2: Top Tool Bar

Table 6.1: Windows Menu		
Windows Menu	**Sub Menu**	**Comment**
Document Menu (Icon)	Restore	Restores active window to previous size
	Move	Allows user to move active window
	Size	Allows user to resize active window
	Minimize	Makes the active window as small as possible
	Maximize	Makes the active window as large as possible
	Close	Closes the active Offliner setting document
	Next	Switches to the next open Offliner setting file, if more than setting file is being edited

Table 6.1: Windows Menu		
File	New	Opens up a default setting file of the most recent setting version
	Open	Open an existing setting file
	Close	Closes the active Offliner setting document
	Save	Saves the active setting file
	Save As	Saves the active setting file with a new name or to a new location
	Convert to Newer	Convert an older setting version to a newer version.
	Print	Prints graphs or setting summary depending on active screen
	Print Preview	Provides a print preview of the setting summary
	Print Setup	Changes printers or print options
	1 – 8	The 8 most recently accessed setting files
	Exit	Quits the program and prompts to save the document if it is not saved
Edit	Undo	Undo last action
	Cut	Cut the selection and puts it on the clipboard
	Copy	Copy the selection and puts it on the clipboard
	Paste	Insert clipboard contents
	Copy Graph	Copy the graph for the active screen to the clipboard
	Copy Setting Group	Copy values from one Setting Group to another
Tools	Options	Print settings for Settings Summary sheet
Window	Cascade	Cascades all open windows
	Tile	Tiles all open windows
	Hide/Show Tree	If this option is checked then the LHS Tree view will be hidden
	1 – 9, More Windows	Allows access to all open Offliner setting files. The active document will have a check beside it
Help	User Manual	Displays the user manual
	About Offliner	Displays the Offliner version

Table 6.1: Windows Menu		
Toolbar	New	Create a new document of the most recent setting version
	Open	Open an existing document
	Save	Save the active document
	Cut	Cut selection
	Copy	Copy the selection
	Paste	Insert clipboard contents
	Undo	Undo last action
	Copy Graph	Copy the graph for the active screen to the clipboard
	Copy Setting Group	Brings up the Copy Inputs dialog box
	Show/Hide LHS Tree	If this option is checked then the LHS Tree view will be hidden
	Print	Prints Graphs or the setting summary, depending on which seen is selected
	About	Displays the Offliner version

6.3 Offliner Keyboard Shortcuts

The following table lists the keyboard shortcuts that Offliner provides.

Table 6.2: Keyboard Shortcuts

Ctrl+N	Opens up a default setting file of the most recent setting version
Ctrl+O	Open an existing setting file
Ctrl+S	Saves the active setting file
Ctrl+Z	Undo
Ctrl+X	Cut
Ctrl+C	Copy
Ctrl+V	Paste
Ctrl+F4	Closes the active Offliner setting document
Ctrl+F6	Switches to the next open Offliner setting file, if more than one setting file is being edited
F6	Toggles between the LHS Tree view and HRS screen
F10, Alt	Enables menu keyboard short-cuts
F1	Displays the user manual

Graphing Protection Functions

Grid On/Grid Off

The graph can be viewed with the grid on or off by clicking the Grid On or Grid Off button. A right-click on the trace of the curve gives you the x and y coordinates.

Print Graph

To print a particular graph, click the *Print Graph* button.

Refresh

This button will manually refresh the graph if it has been zoomed.

Zoom on Graphs

Graphs can be zoomed to bring portions of the traces into clearer display. Left-click on any graph and drag to form a small box around the graph area. When you release the mouse, the trace assumes a new Zoom position determined by the area of the zoom coordinates.

To undo the zoom on the graph, click the Refresh button.

6.4 Handling Backward Compatibility

Offliner Settings displays the version number in the second pane on the bottom status bar. The settings version is a whole number (v1, v2, v3, v4, etc.).

The Offliner Settings is backward compatible. Open and edit older settings files and convert older settings files to a newer version. Offliner Settings handles forward conversion only; it converts an older setting file to a newer setting file.

Converting a Settings File

1. Open the setting file you wish to convert.
2. In the *File* menu, select *Convert to...* and then select the *version x* (where x is the newer version). A dialog box pops up prompting Offliner for a new file name. Use either the same file name or enter a new file name. The conversion process inserts default values for any newly added devices in the new setting file. When the conversion is complete, Offliner Settings displays the new file.

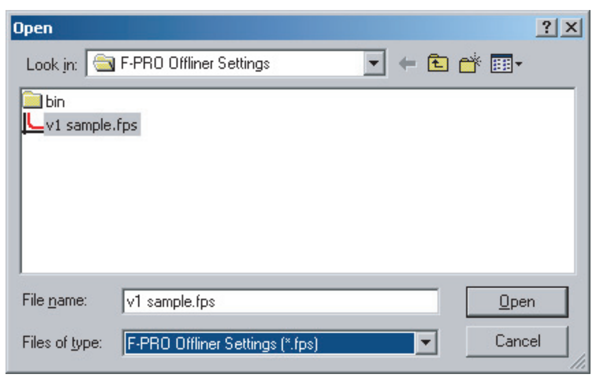


Figure 6.3: Converting Setting Files

Sending a New Setting File to the Relay

1. Make sure the settings version and the serial number of the relay in the setting file match. The relay will reject the setting file if either the serial number or the settings version do not match.

> A "serial number discrepancy" message may appear. This is to ensure that you are aware of the exact relay in which settings are to be loaded. If this happens, check the relay serial number using the terminal mode ID menu item. Type this serial number into the F-PRO Serial No. box in the Identification tab display area of Offliner Settings. Alternately you may check the Ignore Serial Number check box to bypass serial number supervision.

2. Check the serial number and the settings version of the relay. The Device Serial Number and Required Settings Version on the Identification screen indicate the serial number and the settings version of the relay.

Creating a Setting File from an Older Version

1. Offliner Settings displays a default setting file on start up showing the settings version in the bottom status bar. As an example F-PRO Offliner is shipped with a set of default sample files of older settings versions. The sample file is "v1 sample.fps". The sample file contains default values of an older settings version. For a new installation these sample files are placed in the default directory *C:\Program Files\ERLPhase\F-PRO Offliner Settings*, or you can choose the path during the Offliner software installation. If an older version of F-PRO Offliner was previously installed on your PC, then the default directory may be *C:\Program Files\APT\F-PRO Offliner Settings.*
2. Open a sample file of the desired version. Use *File/Save As* to save the sample file to a new file name. Then edit the setting file and the serial number, save it and load it into the relay.

6.5 RecordBase View Software

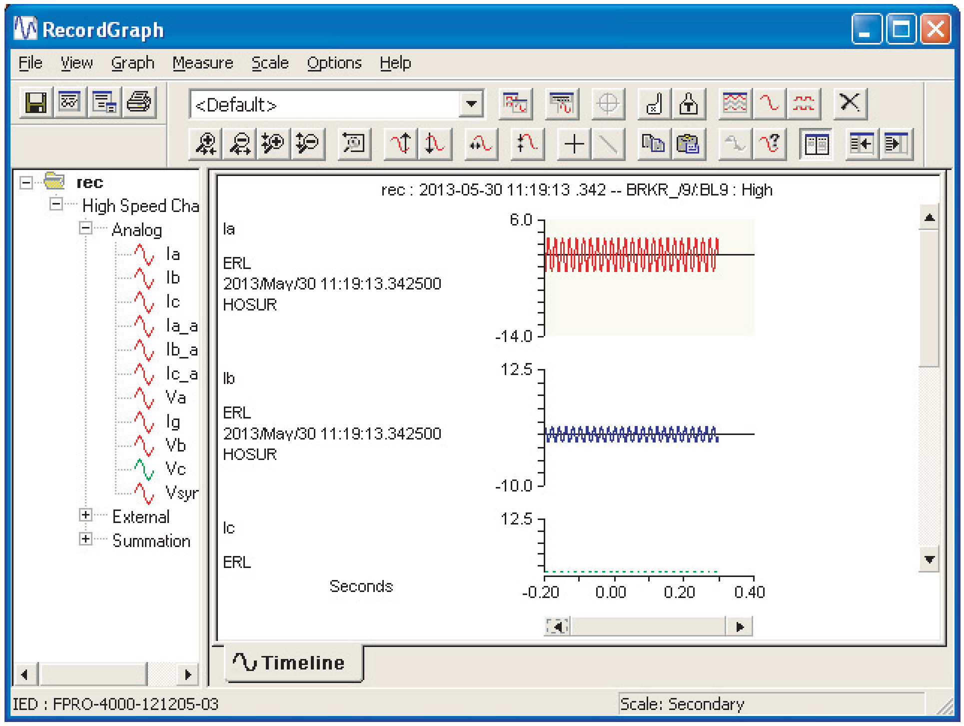


Figure 6.4: RecordBase View

Use RecordBase View to analyze the records from a relay.

1. Set the receive directory on your RCP to point to a convenient directory on your PC's hard disk or network. For example with Relay Control Panel, Select *Add New>Folder Placement>Browse*. It will be by default in this path *C:\Documents and Settings\user\My Documents\ERLPhase\Relay Control Panel\appsupp\Records.*
2. Select one or more records on the relay using the *List* function in the Terminal Mode's *Records* menu.
3. Initiate transfer of the selected record by selecting *GET* from Relay tab in the RCP or by double clicking the selected record.
4. Start the RecordBase View program and use the *ADD* tab to open the downloaded record files located in the receive directory specified in step 1.

For further instructions refer to the RecordBase View Manual at the back of the printed version of this manual.

6.6 Main Branches from the Tree View

This section will describe the tree view, which provides access to the various setting screens. This section will not describe individual settings, but will provide a general description of where to find the individual settings. For a detailed description of the individual settings see Chapter 4.

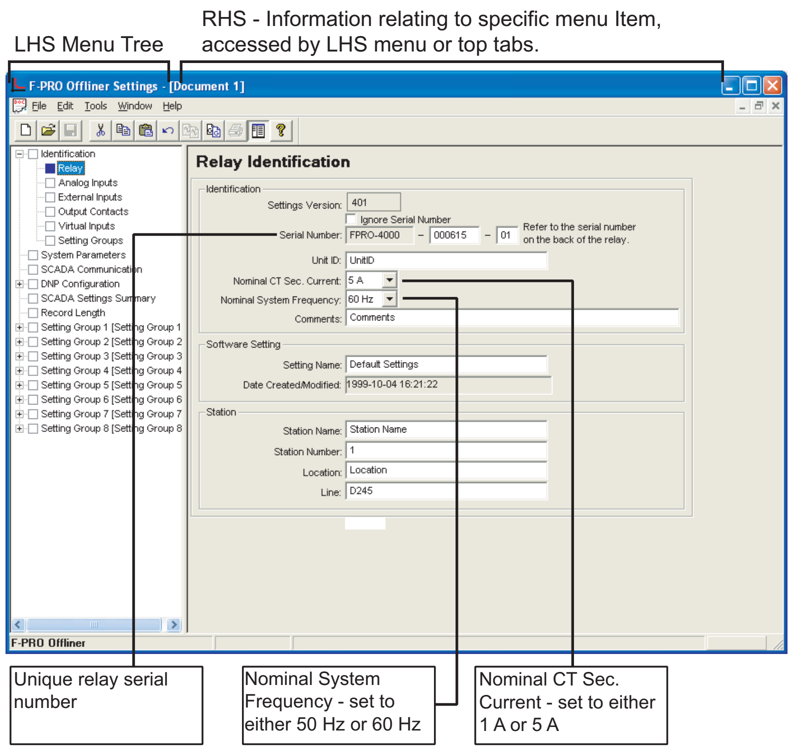


Figure 6.5: Relay Identification

In the LHS Menu Tree there are a series of menu headings that may have sub menus associated with them. Clicking on an item in the left hand side tree view will display its corresponding menu in the RHS view. Similarly, the user can use the arrow keys to scroll through the menu tree.

Identification

The first screen presents all the menu items in the left menu tree. Access the menu items by clicking the tabs at the top of the screen or the item on the left menu tree.

Table 6.3: Relay Identification

Relay Identification	
Identification	
Settings Version	Indicates the settings version number, fixed.
Ignore Serial Number	Bypass serial number check, if enabled.
Serial Number	Available at the back of each relay.
Unit ID	User-defined up to 20 characters.
Nominal CT Format	5 A or 1 A
Nominal System Frequency	60 Hz or 50 Hz
Comments	User-defined up to 78 characters.
Setting Software	
Setting Name	User-defined up to 20 characters.
Date Created/Modified	Indicates the last time settings were entered.
Station	
Station Name	User-defined up to 20 characters.
Station Number	User-defined up to 20 characters.
Location	User-defined up to 20 characters.
Line	User-defined up to 20 characters.

Important Note

Nominal CT Sec. Current can be set to either 5 A or 1 A.

Nominal System Frequency can be set to either 60 Hz or 50 Hz.

Ensure setting selection matches that of target F-PRO.

The serial number of the relay must match the one in the setting file, or the setting will be rejected by the relay. This feature ensures that the correct setting file is applied to the right relay.

Choose to ignore the serial number enforcement in the identification screen by checking the *Ignore Serial Number* check box. The relay only checks for proper relay type and setting version if the ignore serial number has been chosen, requires relay firmware version 1.0 or greater.

Analog Inputs

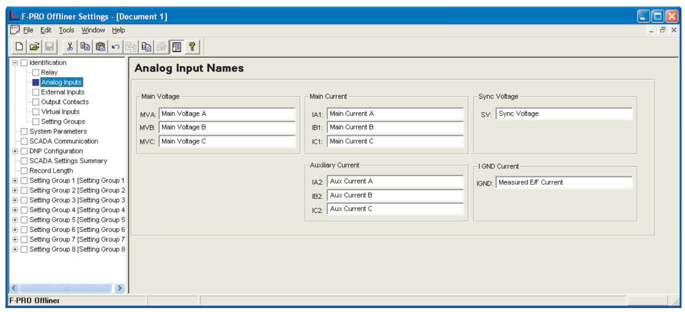


Figure 6.6: Analog Inputs

Analog Inputs screen identifies all the ac voltage and current inputs to the relay. These names appear in any fault disturbance records the F-PRO produces.

Table 6.4: Analog Inputs

Main Voltage	MVA, MVB, MVC
Main Current	IA1, IB1, IC1
Aux. Current	IA2, IB2, IC2
Sync Voltage	SV
Measured E/F	IGND

External Inputs

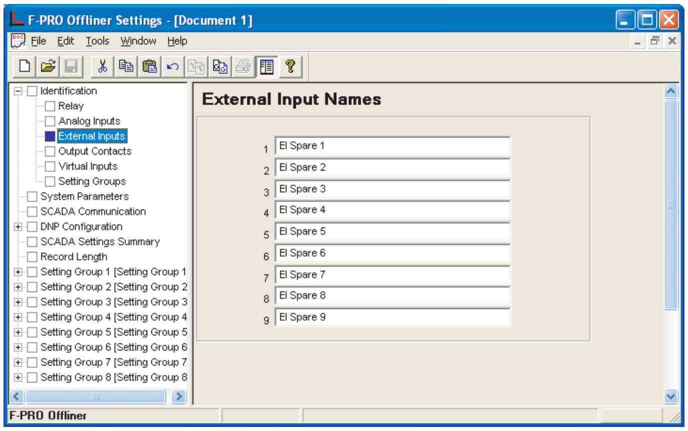


Figure 6.7: External Inputs

The External Inputs screen allows you to define meaningful names for nine external inputs.

Table 6.5: External Input Names	
1 to 9	User-defined

Output Contacts

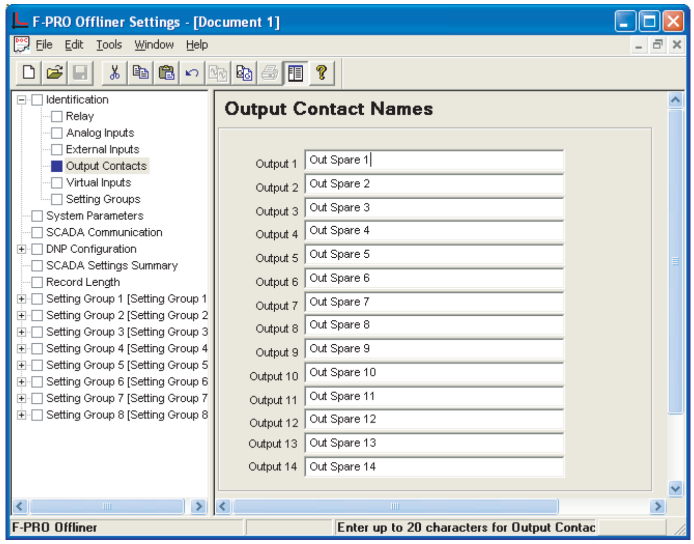


Figure 6.8: Output Contacts

The Output Contact Names screen allows you to define meaningful names to the 14 output contacts.

Table 6.6: Output Contact Names	
Outputs 1 to 14	User-defined

Virtual Inputs

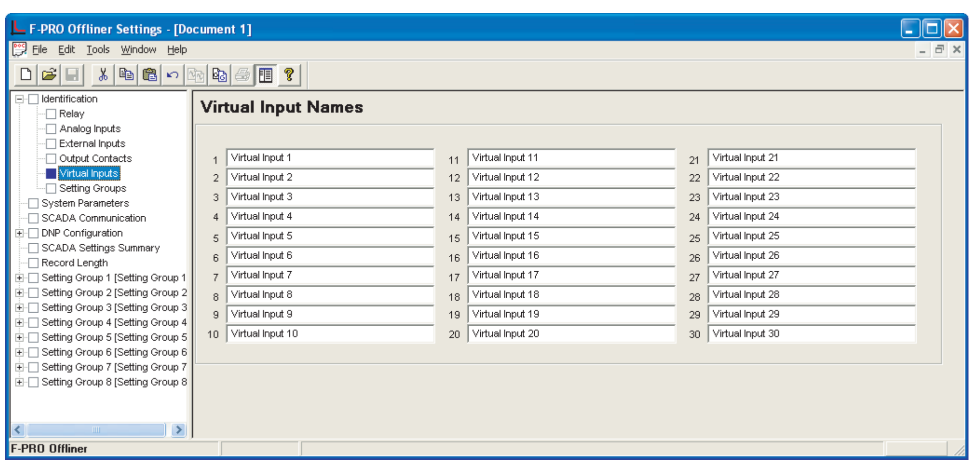


Figure 6.9: Virtual Inputs

Table 6.7: Virtual Inputs	
Virtual Inputs 1 to 30	User-defined

The relay can control its internal functions and connected devices both locally and remotely. Thirty general purpose logic points are accessible via DNP3 and the terminal UI. The 30 virtual inputs are individually controlled and include a set, reset and pulse function. The latch state is retained during setting changes and relay power down conditions. The 30 virtual inputs conform to DNP3 standards. Use the DNP3 functions such as SBO (select before operate), Direct Operate, or Direct Operate with no acknowledge to control virtual inputs.

Use virtual inputs to:

- control circuit breakers
- enable or disable reclosing
- enable or disable under-frequency load shedding
- change setting groups
- provide interlocking between local/remote supervisory control

Setting Groups

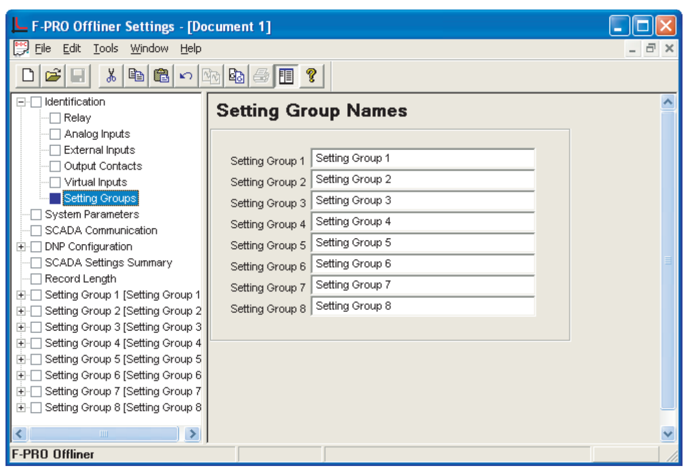


Figure 6.10: Setting Groups

The Setting Group Names screen allows you to define meaningful names to the 8 setting groups.

Table 6.8: Setting Groups	
Setting Groups 1 to 8	User-defined

System Parameters

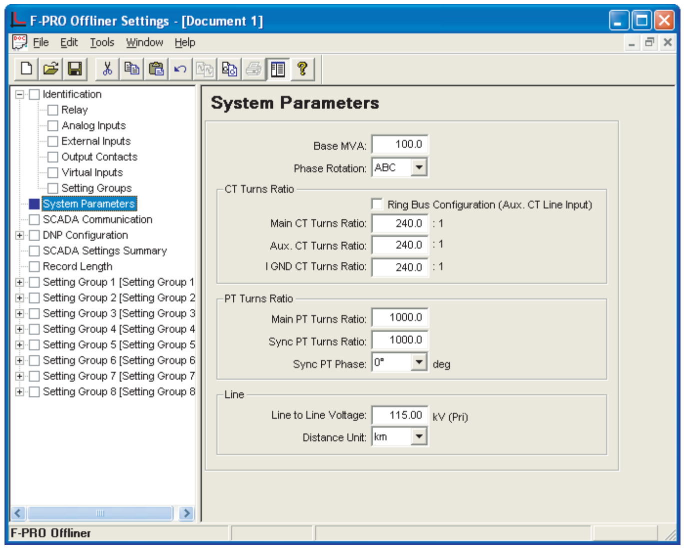


Figure 6.11: System Parameters

Table 6.9: System Parameters

Base MVA	1.0 to 1000.0 MVA (primary)
Phase Rotation	ABC or ACB
CT Turns Ratio	
Ring Bus Configuration (Aux CT Line Input)	Enable/disable * If Aux CT Line Input is enabled, the same ratio of Main CT & Aux. CT is assumed.
Main CT Turns Ratio	1.0 to 30000.0
Aux CT Turns Ratio	1.0 to 30000.0
I GND CT Turns Ratio	1.0 to 30000.0
PT Turns Ratio	
Main PT Turns Ratio	1.0 to 20000.0
Sync PT Turns Ratio	1.0 to 20000.0
Sync PT Phase	0 to 330 degrees (with increments of 30 degree)
Line	
Line to Line Voltage	1.00 to 2000.00 kV (Primary)
Distance Units	km or miles

Base MVA

The base MVA is used for recording purposes.

CT Turns Ratio and PT Turns Ratio

The CT and PT ratios are specified for the analog inputs. All CT and PT ratios are specified with a ratio relative to one (i.e. X amps to 1A). The line protection uses the main current and the main voltage to operate. When two sets of CTs (main and auxiliary) are used as line current input (e.g. ring bus application), you must enable the ring bus configuration parameter to inform the relay. If enabled, the currents from the two sets of CTs are added to the relay to form the line current. F-PRO uses ac volts from the main PTs for its protections and for the metering functions. A single phase voltage from the bus is connected to sync ac volts to provide voltage for sync checking capability. A single phase current channel is used for the neutral current measurement.

Record Length

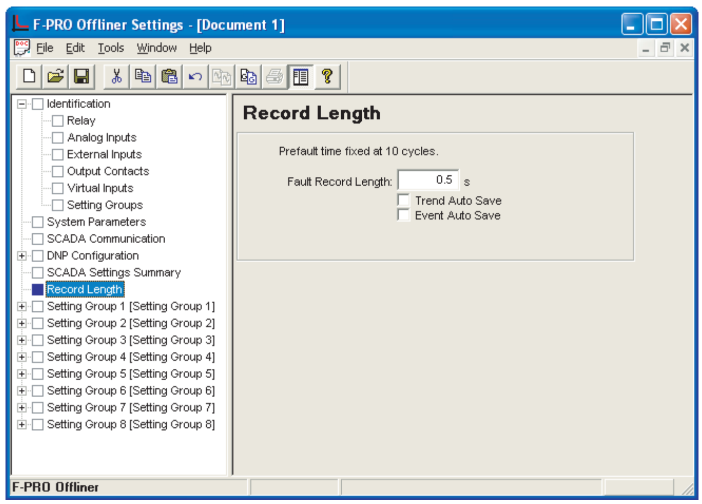


Figure 6.12: Record Length

Table 6.10: Record Length	
Fault Record Length	0.2 to 2.0 seconds
Trend Auto Save	Enable/disable
Event Auto Save	Enable/disable

The relay has recording and logging functions to analyze faults and to review the operation of the overall protection scheme.

This item identifies the amount of time for which each fault is recorded. The prefault time is fixed at 10 cycles.

Setting Groups

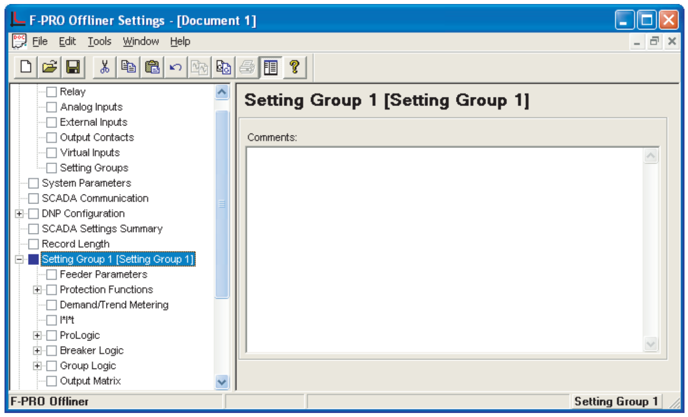


Figure 6.13: Setting Groups Comments

The relay has eight setting groups (1 to 8). You can change all relay setting parameters except the physical connections such as input or output parameters in each setting group. Use any one of the 16 available Group Logic Statements per setting group to perform Setting Group changes. The Group Logic statements are similar to the ProLogic statements with the following exceptions, the sole function is to activate one of the eight setting groups and the processing is in a slower half second cycle. Group Logic inputs statements can be driven from ProLogic, any external input, previous Group Logic statements or virtual inputs. Each Group Logic statement includes five inputs (with Boolean statements), one latch state and one pickup delay timer. View the active setting group from the Terminal Mode, from the front panel or from a record stored by the relay (the active setting group is stored with the record).

Feeder Parameters

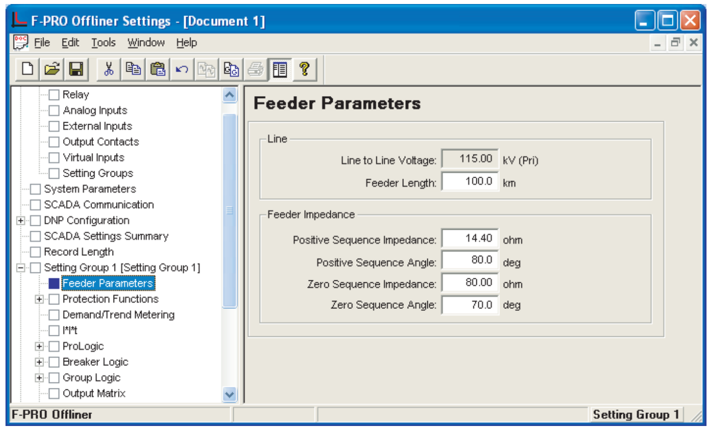


Figure 6.14: Feeder Parameters

Table 6.11: Feeder Parameters	
Line	
Line to Line Voltage	Interlock with system parameters
Feeder Length	0.5 to 1000 (km) or 0.3 to 621.4 (miles)
Feeder Impedance	
Positive Sequence Impedance Magnitude	0.05 to 66.00 Ohms secondary (5 A) 0.25 to 330 Ohms secondary(1 A)
Positive Sequence Impedance Angle	5.0 to 89.0 degrees
Zero Sequence Impedance Magnitude	0.05 to 200.00 Ohms secondary (5 A) 0.25 to 1000 Ohms secondary(1 A)
Zero Sequence Impedance Angle	5.0 to 89.0 degrees

Feeder Parameters permit a parameter entry related to the line voltage, CT ratio, PT ratio, line length, line secondary positive and zero sequence impedance. The relay internally calculates Ko from these values. The K0 factor used is a default factor based on the line parameters (K0 = [Z0- Z1] / 3Z1).

Feeder parameters are entered in secondary quantities.

Protection Functions

For detailed descriptions of the protection functions see “Protection Functions and Specifications” on page 4-1.

Demand/Trend Metering

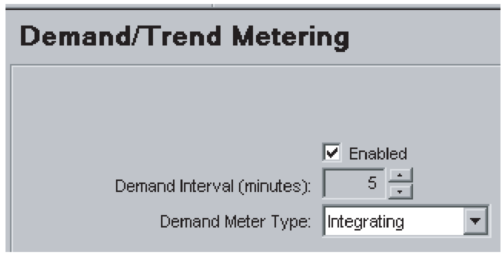


Figure 6.15: Demand/Trend Metering

Table 6.12: Demand/Trend Metering	
Demand/Trend Metering	Enable/disable
Demand Interval (minutes)	5 to 60 minutes with increments of 5
Demand Meter Type	Integrating, rolling or thermal

I*I*t

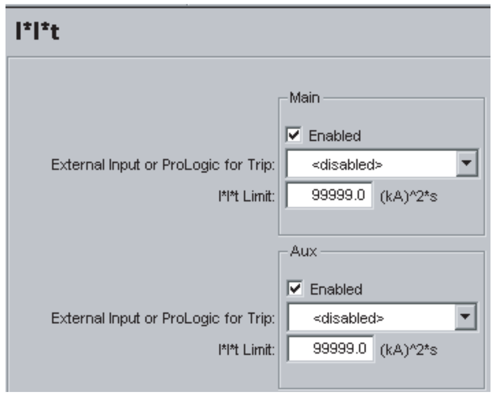


Figure 6.16: I*I*t

Table 6.13: I*I*t	
Main	Enable/disable
External Input or ProLogic for Trip	Disable or External Input or ProLogic
I*I*t Limit	0.1 to 99999.0 $(KA)^2.s$
Aux	Enable/disable
External Input or ProLogic for Trip	Disable or External Input or ProLogic
I*I*t Limit	0.1 to 99999.0 $(KA)^2.s$

ProLogic

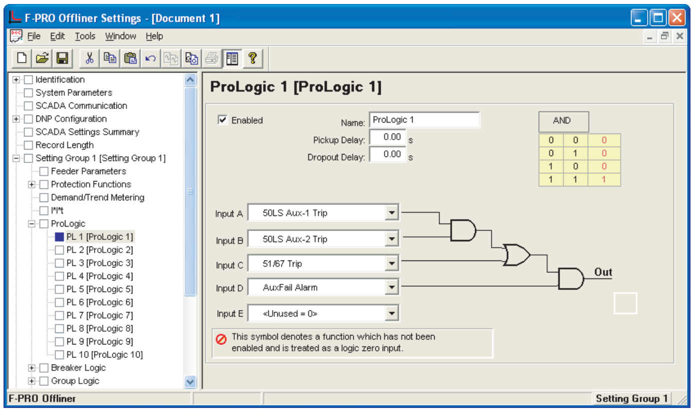


Figure 6.17: ProLogic

Apply ProLogic to multiple inputs to create an output based on qualified inputs. ProLogic enables up to 10 ProLogic control statements and programs those logics to output contacts. You can name the function being created and set a pickup and dropout delay. Start with input A by selecting any of the relay functions using the list for up to 5 possible inputs. Put these inputs into AND/OR, NAND/NOR, XOR/NXOR and LATCH logic by clicking on the gate. Invert the input by clicking on the input line.

The output of ProLogic 1 can be nested into ProLogic 2 and so forth. If desired you can illuminate the front target LED on operation of this function by disabling this feature in output matrix. The operation of the ProLogic statements are logged on the events listing. The status of the prologic can be seen from the record graph by selecting the recorder in the output matrix.

Breaker Logic

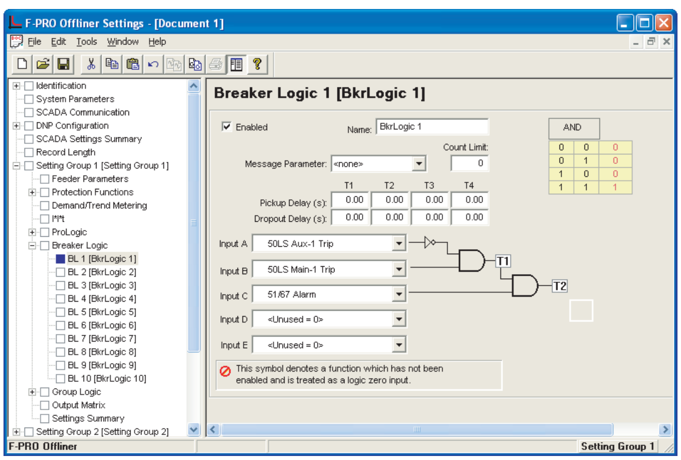


Figure 6.18: Breaker Logic

Group Logic

The sixteen Group Logic statements reside in a slower processing thread within the relay protection algorithms. The processing cycle happens once every half second (0.5 s). When using ProLogic statements you must keep in mind that a latch or dropout timer should be used if the initiating condition does not last at least 0.5 seconds.

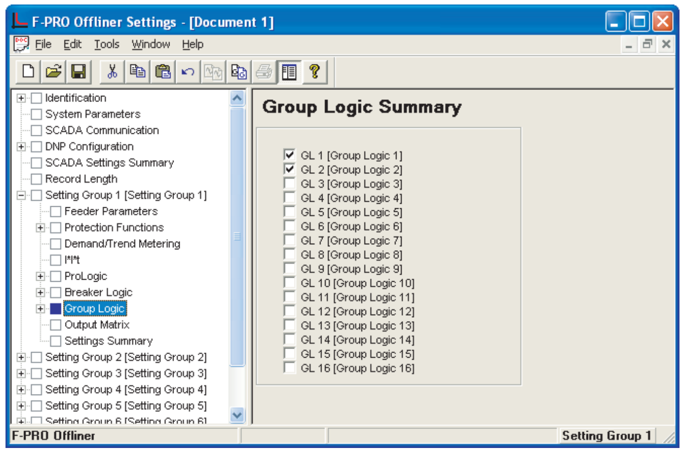


Figure 6.19: Group Logic

Output Matrix

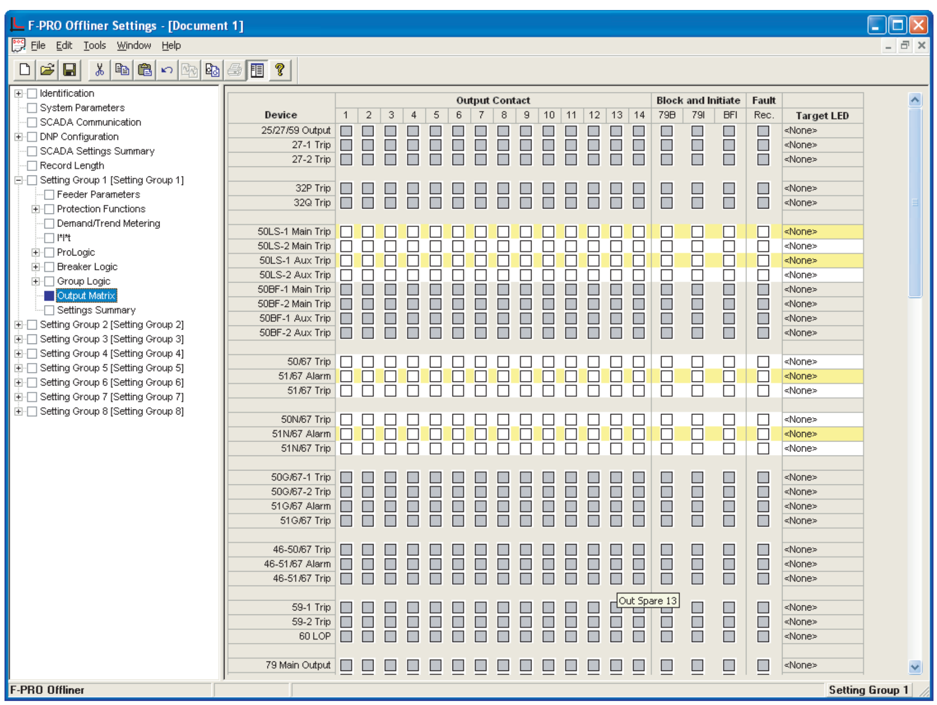


Figure 6.20: Output Matrix 1

The output contact matrix determines which function initiates which output relay. All output relays have a fixed 0.1 second stretch time. Functions can also

initiate fault recording, recloser blocking, recloser initiation and/or breaker failure initiation.

For a particular function to operate correctly, it must be enabled and must also have its logic output assigned to at least one output contact if it is involved in a tripping function.

Print the entire output matrix by selecting *File>Print Summary*. This printout is produced on two pages.

Settings Summary

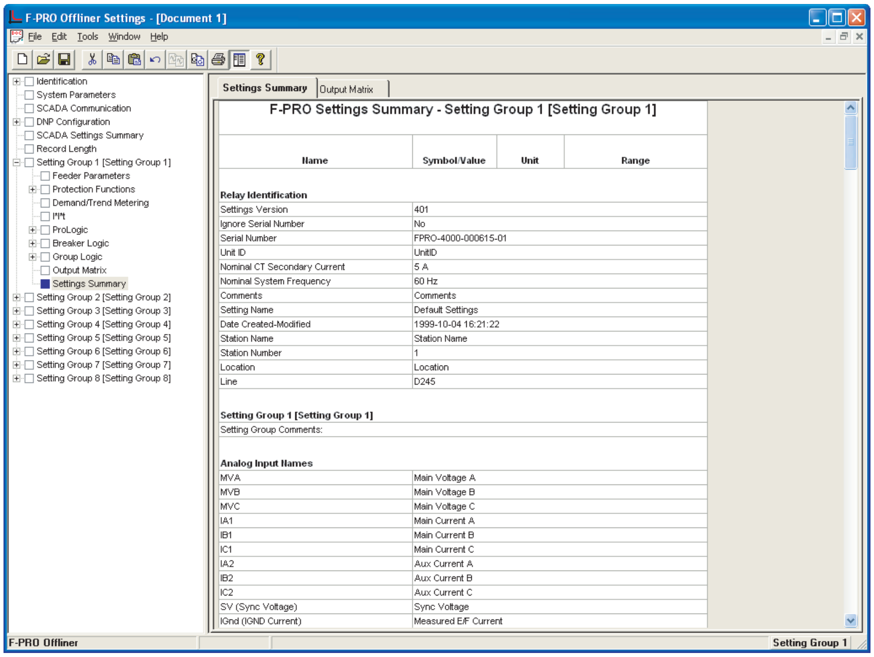


Figure 6.21: Settings Summary

Select *Settings Summary* to view and print the relay settings in text form. For details see “IED Settings and Ranges” in Appendix B. Print the entire Settings Summary by selecting *File>Print Summary*.

6.7 Settings From a Record

The settings on the relay at the time of a recording are included in every record and can be viewed through the RecordBase View analysis software. While viewing a recording in RecordBase View, select the *View Setting* button to display the settings. RecordBase View will automatically launch F-PRO Offliner to display the settings in summary form.

If the record contains Setting Groups, the Offliner displays all Setting Groups in the summary. Bold text in the tree view indicates an active Setting Group (the Setting Group used at the time the record was captured). The setting summary is read-only. To edit the setting file associated with the summary, you must use *File/Save As* to save the summary to a file. Then close the summary screen and open the setting file for editing.

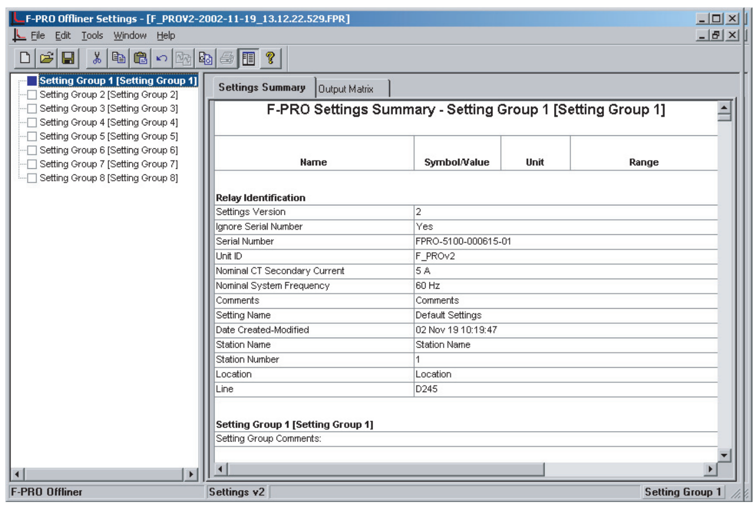


Figure 6.22: View Setting Summary in RecordBase View

7 Acceptance/Protection Function Test Guide

7.1 Relay Testing

ERLPhase relays are fully tested before leaving the factory. A visual inspection of the relay and its packaging is recommended on receipt to ensure the relay was not damaged during shipping.

The electronics in the relay contain static sensitive devices and are not user-serviceable. If the front of the relay is opened for any reason exposing the electronics, take extreme care to ensure that the user and the relay are solidly grounded.

Generally an analog metering check, as well as testing the I/O (External Inputs and Output Contacts) is sufficient to ensure the functionality of the relay. Further tests can be performed on delivery and acceptance of the purchaser's option according to the published relay specifications in "IED Settings and Ranges" in Appendix B.

Test Equipment Requirements

1. Set of 3 phase ac voltage sources and 1 set of single phase ac voltage source
2. Set of 3 phase ac current sources and 1 set of single phase ac current source
3. 1 ohmmeter
4. 48 to 220 Vdc test supply

Set nominal CT secondary current to either 5 A or 1 A, and nominal system frequency to either 60 Hz or 50 Hz. This example uses 1 A/ 60 Hz.

Calibration

The relay is calibrated before it leaves the factory; but if component changes are made within the relay, the user may need to do a re-calibration.

Before you begin a new calibration establish the accuracy of the equipment being used.

To perform a calibration, you must be logged into the relay in Relay Control Panel at the *Service* access level:

1. Proceed to the *Utilities > Analog Input Calibration tab*. The Analog Input Calibration screen lists all of the F-PRO analog input channels.

2. Select the channel to calibrate with your mouse (you may select and calibrate multiple channels at once as long as they are the same qualities).
3. Enter the exact Magnitude of the Applied Signal you are applying your test source.
4. Execute the *Calibrate Offset* and *Gain* button.

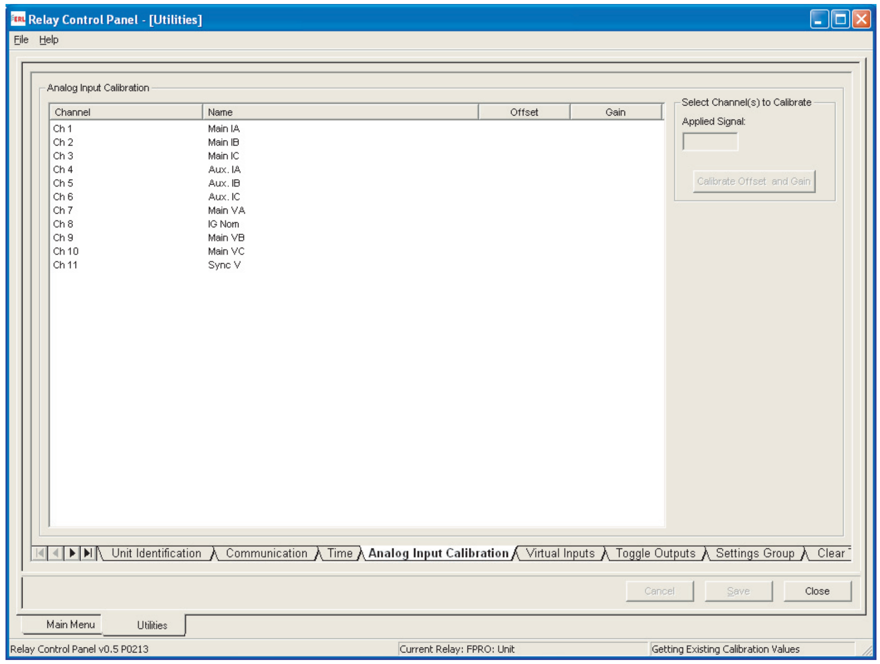


Figure 7.1: Calibration

If the applied test signal is not reasonable, an error will be displayed and the calibration will not be applied. For example, in Figure 7.2: Calibration Error on page 7-3, the displayed calibration error message indicates that we tried to calibrate a 1 A level with no current applied, which is not reasonable.

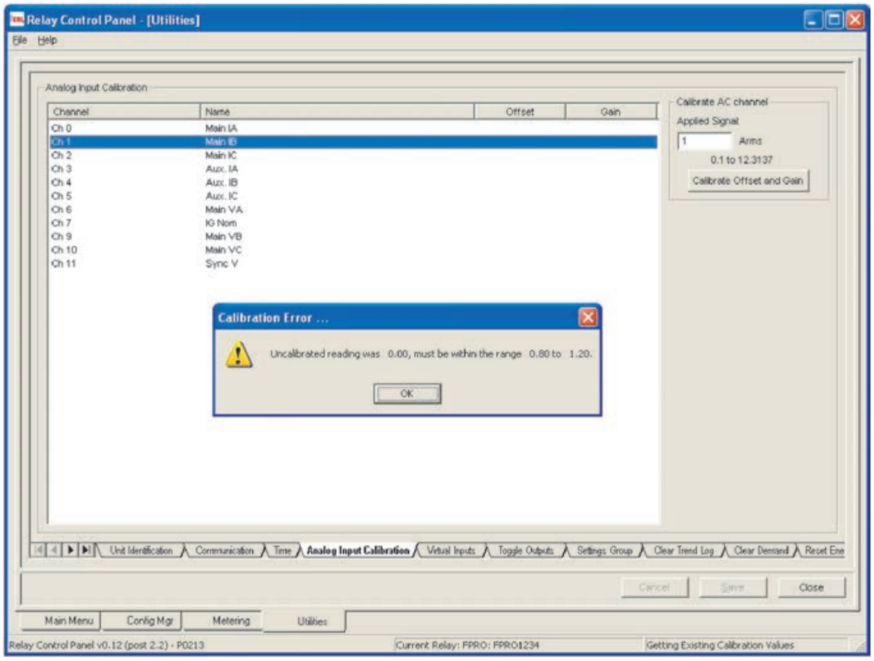


Figure 7.2: Calibration Error

Only the magnitude (gain) and offset are calibrated, not the angle.

When an analog input channel is calibrated, you can verify the quantity measured by selecting the *Metering* menu and the *Input* submenu.

Testing the External Inputs

To test the external inputs connect the relay using Relay Control Panel, *Metering > Digital I/O*. This screen displays the status of the Input and Output Contacts. Placing a voltage of 125 Vdc nominal, (150 Vdc maximum), to each of the external inputs in turn causes the input to change from Low to High status. These inputs are polarity sensitive and this screen has a 0.5 second update rate.

Testing the Output Relay Contacts

Access the F-PRO service level in Relay Control Panel. Open the *Utilities > Toggle Outputs* tab screen. To toggle outputs you first need to enter Test Mode by selecting the Relay in Test Mode check box. When you check the box, a message will appear prompting you to confirm that you really want to enter this mode. Once you enter Test Mode, the red Test Mode LED on the front of the F-PRO will illuminate and it will remain illuminated until you exit Test Mode. The protection functions cannot access the output contacts in Test Mode; they are controllable only by the user via Relay Control Panel. To toggle a particular output, select it from the drop down list and then click on the closed button. You can verify the contact is closed with an ohmmeter. The contact will remain closed until you either click the Open button or exit Test Mode

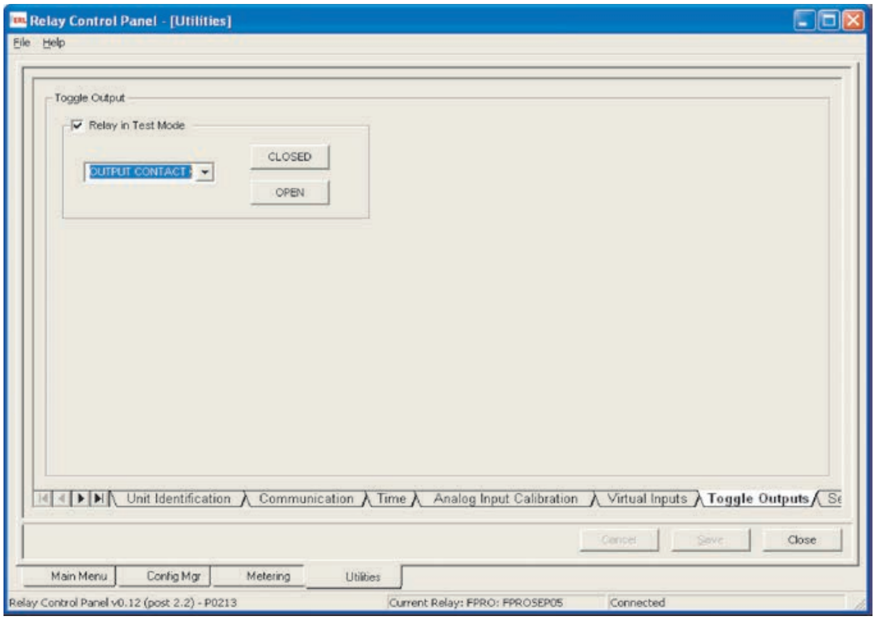


Figure 7.3: Toggle Output

7.2 F-PRO Acceptance Test Procedure Outline

Devices to Test

- 50 LS Low set overcurrent
- 50BF Breaker Failure
- 50/51/67) Phase Overcurrent
- 50N/51N/67) Neutral Overcurrent
- 50G/51G/67) Measured Neutral Overcurrent
- 46-50/46-51/67) Negative Sequence Overcurrent
- 25/27/59) Sync Check
- 79) Recloser
- 59) Overvoltage
- 27) Under voltage
- 60) Loss of Potential Alarm
- 81) Over/Under/Rate of Change of Frequency
- 32) Directional Power
- 21P) Phase Distance
- THD Alarm
- Demand/Trend Metering
- I*I*t

50 LS – Low Set Overcurrent

Settings

50 LS-1 Main	Enable	50 LS-2 Main	Enable
Gate switch	OR	Gate switch	AND
Pickup	2.00 A	Pickup	2.00 A
Time Delay	1 second	Time Delay	1 second

50 LS-1 Aux	Enable	50 LS-2 Aux	Enable
Gate switch	OR	Gate switch	AND
Pickup	2.00 A	Pickup	2.00 A
Time Delay	1 second	Time Delay	1 second

Test Procedure

1. In Relay Control Panel access relay *Metering*.

Logic→	Digital IO→
50LS-1 Main Trip	Output 11 (50LS-1 Main Trip)
50LS-2 Main Trip	Output 12 (50LS-2 Main Trip)
50LS-1 Aux Trip	Output 13 (50LS-1 Aux Trip)
50LS-2 Aux Trip	Output 14 (50LS-2 Aux Trip)

2. Apply balanced 3-phase nominal current (1.0 A) to the relay terminals.
   Main Ph A: 300 – 301: 1.0∠0° Aux Ph A: 306 – 307: 1.0∠0°
   Main Ph B: 302 – 303: 1.0∠240° Aux Ph B: 308 – 309: 1.0∠240°
   Main Ph C: 304 – 305: 1.0∠120° Aux Ph C: 310 – 311: 1.0∠120°
   Observe:
   Metering

Logic→	Digital IO→
50LS-1 Main Trip: Low	Output 11: open
50LS-2 Main Trip: Low	Output 12: open
50LS-1 Aux Trip: Low	Output 13: open
50LS-2 Aux Trip: Low	Output 14: open

3. Gradually increase the Main / Aux - A /B/C phase current above the setting value until 50LS-1 Main Trip / 50LS-1 Aux Trip becomes high and Output 11/ Output 13 closed.
4. Gradually increase the Main / Aux - A, B & C phase current above the setting value until 50LS-2 Main Trip / 50LS-2 Aux Trip becomes high and Output 12/ Output 14 closed.

50BF (Breaker Fail) and 50LS (Low Set Overcurrent) Tests

Settings

50 LS-1 Main	Enabled	50 BF Main	Enabled
Gate switch	OR	Pickup Delay1	0.2
Pickup	2.00 A	Pickup Delay2	0.4
Pickup Delay	1 second	Pickup Delay	1 second
50 LS-1 Aux	Enabled	Breaker current pickup	1.00
Gate switch	OR	Pickup Delay1	0.2
Pickup	2.00 A	Pickup Delay2	0.4
Pickup Delay	1 second	Breaker current pickup	1.00

50LS Main and Aux. Breaker Fails are set to be initiated via the Output Matrix.

50BF and 50LS Test Procedure

1. In Relay Control Panel access relay *Metering*.

Logic→	Digital IO→
50LS-1 Main Trip	Output 09 (50LS-1 Main Trip)
50LS-1 Aux Trip	Output 10 (50LS-1 Aux Trip)
50BF-1 Main Trip	Output 11 (50BF-1 Main Trip)
50BF-2 Main Trip	Output 12 (50BF-2 Main Trip)
50BF-1 Aux Trip	Output 13 (50BF-1 Aux Trip)
50BF-2 Aux Trip	Output 14 (50BF-2 Aux Trip)

2. Gradually increase the Main / Aux - A /B/C phase current above the setting value until 50LS-1 Main Trip / 50LS-1 Aux Trip becomes high and Output 09/ Output 10 closed.

   0.2 seconds later, Output Contact 11/13 = Closed (50BF Main-1 Trip)

   After an additional 0.2 seconds Output Contact 12/14 = Closed (50BF Main-2 Trip)

3. Turn current off.

   50LS Main /Aux = Low and Output Contacts 09 / 10 = Open

   50BF Main /Aux = Low and Output Contacts = Open

50/51/67 Phase Overcurrent Test (Phase Instantaneous and Time Overcurrent)

Test Settings

50/67	Enable
51/67	Enable
Directional	Non-Directional/Forward/Reverse
50/67 Pickup	2.0 A
51/67 Pickup	1.5 A
Curve type	IEC STD Inverse
TMS	0.5
A	0.14
B	0.00
P	0.02
Output 09	(51/67 Alarm)
Output 10	(51/67 Trip)
Output 11	(50/67 Trip)

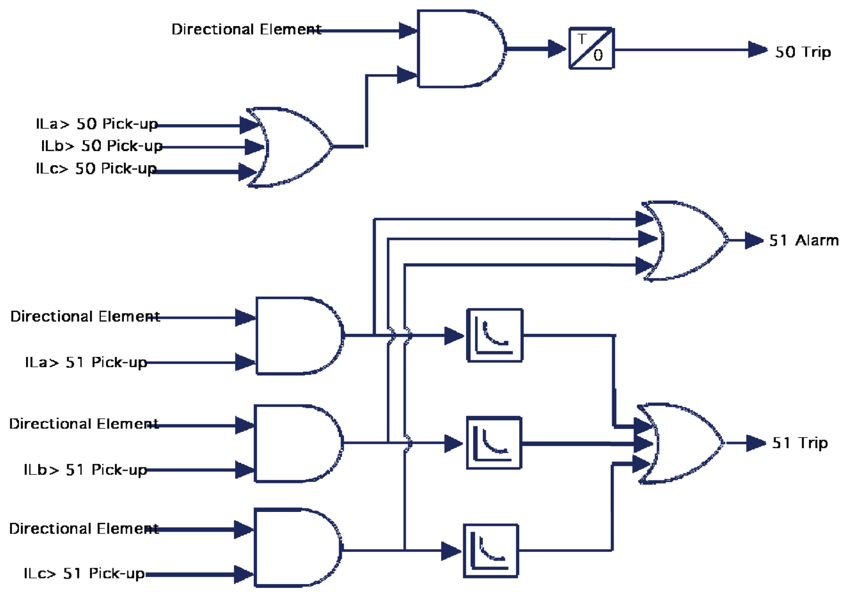


Figure 7.4: Protection Logic 50/51/67

50/67 and 51/67 Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.
2. Apply balanced 3-phase currents (1 A) and voltage (63.5) to the relay terminals.

   Main Ph A: 300 – 301: 1.0∠0°Aux Ph A: 306 – 307: 1.0∠0°

   Main Ph B: 302 – 303: 1.0∠240°Aux Ph B: 308 – 309: 1.0∠240°

   Main Ph C: 304 – 305: 1.0∠120°Aux Ph C: 310 – 311: 1.0∠120°

   Main Ph VA: 314 – 315: 63.5∠0°

   Main Ph VB: 316 – 317: 63.5∠240°

   Main Ph VC: 318 – 319: 63.5∠120°
3. Slowly ramp up the current.

   At 1.43 to 1.58 A (expect 1.5 A)

   51/67 Alarm = High and Output contact 09 (51/67 Alarm)
4. Continue to raise current.

   At 1.9 to 2.1 A (expect 2.0 A):

   50/67 Trip = High and Output contact 11 (50/67 Trip)
5. Turn current off.

   51/67 Alarm = Low & 50 Trip = Low

51/67 Timing Test

1. Monitor (Timer Stop) on Output Contact 10.
2. Set timer start from single-phase 0.0 A to 15.00 A transition (this equates to 10x pickup).

$$t(I) = \left[0.5 * \frac{0.14}{\left[\frac{15}{1.5}\right]^{0.02} - 1} + 0\right] \quad \left[0.5 * \frac{0.14}{\left[\frac{15}{1.5}\right]^{0.02} - 1} + 0\right] = 1.5 \text{ sec} \quad (1)$$

Observe Relay Target: "51 Trip on A"

51/67 Directional Tests

Directionality is based on Vpos divided by Ipos angle.

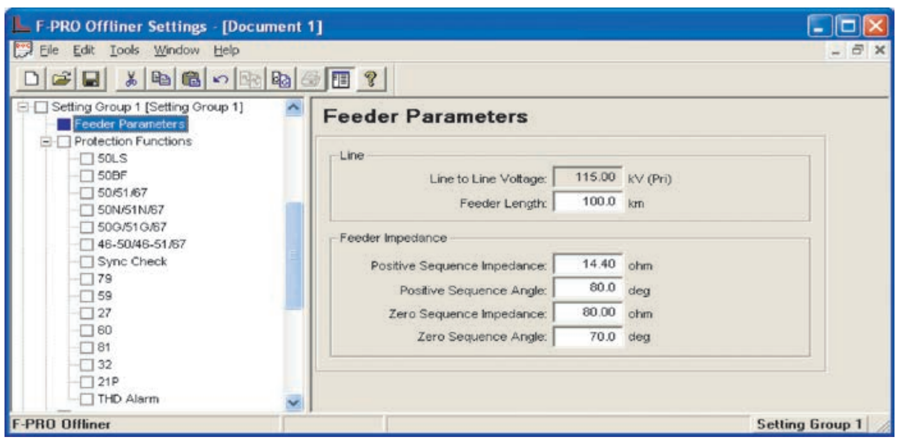


Figure 7.5: Feeder Parameter

Line Angle = 80° (i.e. current lags voltage by 80°)

Note: Required Operating Range = ± 90°from line angle

51/67 Directional Test Procedure

1. In Relay Control Panel access relay *Metering > Logic.*
   51/67 Alarm
2. Apply single-phase polarizing voltage to:
   Main Ph VA: 314 – 315: 63.5 V∠0°
3. Apply single-phase current at line angle to:
   Main Ph A: 300 – 301: 2.0 A ∠-80°
   Observe 51 /67 Alarm = High
4. Slowly ramp the current phase angle in negative direction (i.e. more lag):
   At -165°to -175° (expect -170°):

51/67 Alarm = Low

5. Restore current to line angle (-80°):
   Observe 51/67 Alarm = High
6. Slowly ramp the current phase angle in positive direction (i.e. less lag):
   At +5°to +15° (expect +10°):
   51/67 Alarm = Low
7. Turn off voltage and current sources.
   End of 50/51/67 test.

50N/51N/67 Neutral Overcurrent Test

Test Settings

50N/67	Enable
51N/67	Enable
Directional	Non-Directional/Forward/Reverse
50N/67 Pickup	2.0 A
51N/67 Pickup	1.5 A
Curve type	IEC STD Inverse
TMS	0.5
A	0.14
B	0.00
P	0.02
Output 09	(51N/67 Alarm)
Output 10	(51N/67 Trip)
Output 11	(50N/67 Trip)

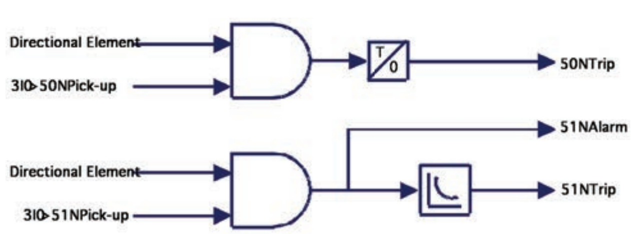


Figure 7.6: Protection Logic 50N/51N/67

50N/67 and 51N/67 Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.
2. Apply balanced 3-phase currents (1 A) and voltage (63.5) to the relay terminals.

   Main Ph A: 300 – 301: 1.0∠0°Aux Ph A: 306 – 307: 1.0∠0°

   Main Ph B: 302 – 303: 1.0∠240°Aux Ph B: 308 – 309: 1.0∠240°

   Main Ph C: 304 – 305: 1.0∠120°Aux Ph C: 310 – 311: 1.0∠120°

   Main Ph VA: 314 – 315: 63.5∠0°

   Main Ph VB: 316 – 317: 63.5∠240°

   Main Ph VC: 318 – 319: 63.5∠120°
3. Slowly ramp up the current.

   At 1.43 to 1.58 A (expect 1.5 A)

   51N/67 Alarm = High and Output contact 09 (51N/67 Alarm)
4. Continue to raise current.

   At 1.9 to 2.1 A (expect 2.0 A):

   50N/67 Trip = High and Output contact 11 (50N/67 Trip)
5. Turn current off.

   51N/67 Alarm = Low & 50N Trip = Low

51N/67 Timing Test

1. Monitor (Timer Stop) on Output Contact 10.
2. Set timer start from single-phase 0.0 A to 15.00 A transition (this equates to 10x pickup).

$$t(I) = \left[0.5 * \frac{0.14}{\left[\frac{15}{1.5}\right]^{0.02} - 1} + 0\right] \quad \left[0.5 * \frac{0.14}{\left[\frac{15}{1.5}\right]^{0.02} - 1} + 0\right] \quad = 1.5 \text{ sec} \qquad (2)$$

Observe Relay : “51N/67 Trip”.

51N/67 Directional Tests

Directionality is based on Vpos divided by Ipos angle.

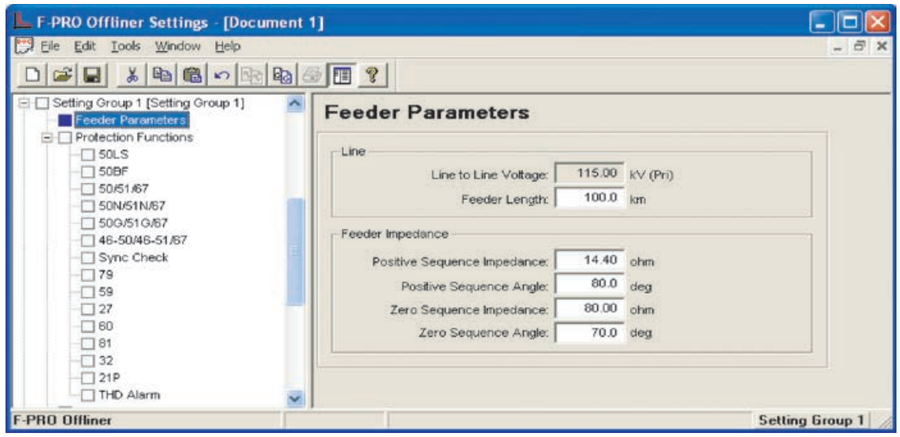


Figure 7.7: Feeder Parameter

Line Angle = 80° (i.e. current lags voltage by 80°)

Note: Required Operating Range = ±90° from line angle

51N/67 Directional Test Procedure

1. In Relay Control Panel access relay *Metering > Logic*.
   51N/67 Alarms
2. Apply single-phase polarizing voltage to:
   Main Ph VA: 314 – 315: 63.5 V∠0°
3. Apply single-phase current at line angle to:
   Main Ph A: 300 – 301: 2.0 A ∠-80°
   Observe 51N/67 Alarm = High
4. Slowly ramp the current phase angle in negative direction (i.e. more lag):
   At -165°to -175° (expect -170°):
   51N/67 Alarm = Low
5. Restore current to line angle (-80°):
   Observe 51N/67 Alarm = High
6. Slowly ramp the current phase angle in positive direction (i.e. less lag):
   At +5°to +15° (expect +10°):
   51N/67 Alarm = Low
7. Turn off voltage and current sources.
   End of 50N/51N/67 test.

50G/51G/67 Measured Neutral Overcurrent Test

Test Settings

50G-1/67	Enable
50G-2/67	Disable
51G/67	Enable
Directional	Non-Directional/Forward/Reverse
50G-1/67 Pickup	2.0 A
50G-2/67 Pickup	2.0 A
51G/67 Pickup	1.5 A
Curve type	IEC STD Inverse
TMS	0.5
A	0.14
B	0.00
P	0.02
Output 09	(51G/67 Alarm)
Output 10	(51G/67 Trip)
Output 11	(50G-1/67 Trip)
Output 12	(50G-2/67 Trip)

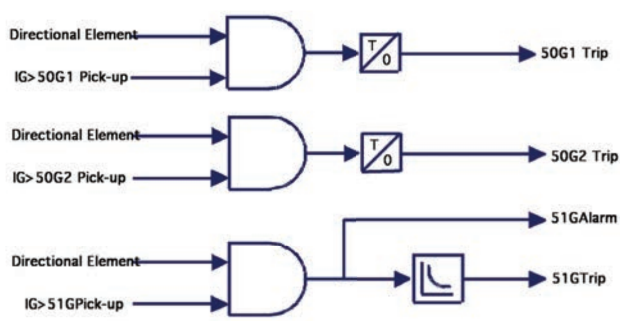


Figure 7.8: Protection Logic 50G/51G/67

50G/67 and 51G/67 Test Procedures

1. In Relay Control Panel access relay *Metering* > *Logic*.
2. Apply balanced 1-phase currents (1 A) and balanced 3- phase voltage (63.5) to the relay terminals.

   IGND: 312 – 313: 1 ∠0°

Main Ph VA: 314 – 315: 33.5∠0°

Main Ph VB: 316 – 317: 63.5∠240°

Main Ph VC: 318 – 319: 63.5∠120°

3. 3Slowly ramp up the current.

   At 1.43 to 1.58 A (expect 1.5 A)

   51G/67 Alarm = High and Output contact 09 (51G/67 Alarm)

4. 4Continue to raise current

   At 1.9 to 2.1 A (expect 2.0 A):

   50G-1/67 Trip = High and Output contact 11 (50G-1/67 Trip)

5. Turn current off.

   51G/67 Alarm = Low & 50G-1/67 Trip = Low

51G/67 Timing Test

1. Monitor (Timer Stop) on Output Contact 10.
2. Set timer start from single-phase 0.0 A to 15.00 A transition (this equates to 10x pickup).

$$t(I) = \left[0.5 * \frac{0.14}{\left[\frac{15}{1.5}\right]^{0.02} - 1} + 0\right] \quad \left[0.5 * \frac{0.14}{\left[\frac{15}{1.5}\right]^{0.02} - 1} + 0\right] = 1.5 \text{ sec} \qquad (3)$$

Observe Relay Target: “51G/67 Trip”.

51G/67 Directional Tests

Directionality is based on 3V0 and I_{GND} angle.

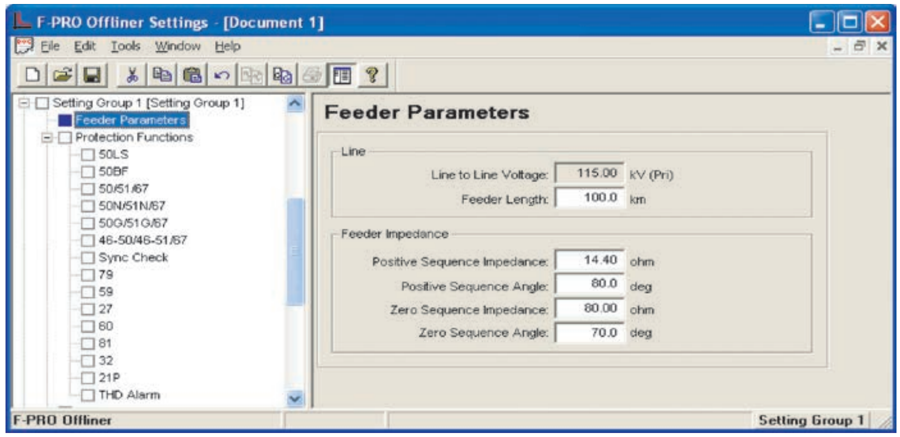


Figure 7.9: Feeder Parameter

Fault angle α = (Angle of $3V_0$ + 180°) – (Angle of I_G)

Forward: Ø - 90° < α < Ø + 90°

Reverse: Ø +90° < α < Ø - 90°

Note:

Ø = Positive sequence angle setting

51G/67 Directional Test Procedures

1. In Relay Control Panel access relay *Metering* > *Logic*.
   51G/67 Alarms
2. Apply single-phase polarizing voltage to:
   Main Ph VA: 314 – 315: 60.5 V∠0°
   Main Ph VB: 316 – 317: 63.5 V∠240°
   Main Ph VC: 318 – 319: 63.5 V∠120°
3. Apply single-phase current at line angle to:
   GND: 312-313: 2 ∠0°
   Observe 51G/67 Alarm = High
4. Slowly ramp the current phase angle in negative direction (i.e. more lag):
   At -10° < α <170° (expect 170°)
   51G/67 Alarm = Low
5. Turn off voltage and current sources.
   End of 50G/51G/67 test.

46-50/46-51/67 Negative Sequence Overcurrent Test

Test Settings

46-50/67	Enable
46-51/67	Enable
Directional	Non-Directional/Forward/Reverse
46-50/67 Pickup	0.1 A
46-51N/67 Pickup	0.1 A
Curve type	IEC STD Inverse
TMS	0.5
A	0.14
B	0.00
P	0.02
Output 09	(46-51/67 Alarm)
Output 10	(46-51/67 Trip)
Output 11	(46-50/67 Trip)

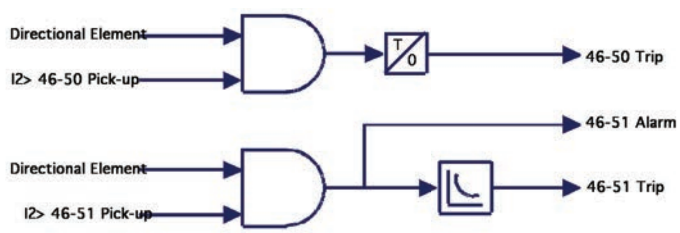


Figure 7.10: Protection Logic 46-50/46-51/67

46-50/67 and 46- 51/67 Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.
2. Apply balanced 3-phase currents(1 A) and voltage (63.5) to the relay terminals.

   Main Ph A: 300 – 301: 1.0∠0°Aux Ph A: 306 – 307: 1.0∠0°

   Main Ph B: 302 – 303: 1.0∠240°Aux Ph B: 308 – 309: 1.0∠240°

   Main Ph C: 304-305: 1.0∠120°Aux Ph C: 310 – 311: 1.0∠120°

   Main Ph VA: 314 – 315: 63.5∠0°

   Main Ph VB: 316 – 317: 63.5∠240°

   Main Ph VC: 318 – 319: 63.5∠120°
3. Slowly ramp down the A Phase current.

At 0.095 to 0.105 A (expect 0.1 A)

46-51/67 Alarm = High and Output contact 09 (46-51/67 Alarm)

4. Continue to ramp down the A Phase current

   At 0.095 to 0.105 A (expect 0.1 A)

   46-50/67 Trip = High and Output contact 11 (46-50/67 Trip)

5. Turn current off.

6. 46-51/67 Alarm = Low & 46-50/67 Trip = Low

46-51N/67 Timing Test

1. Monitor (Timer Stop) on Output Contact 10.
2. Set timer start from A-phase 0.0 transition (this equates to 3 x pickup).

$$t(I_2) = \left(\frac{A}{\left(\frac{I_2}{Ipickup}\right)^p - 1} + B \right) \times TMS \qquad (4)$$

Observe Relay Target: “46-51/67 Trip”

46-51/67 Directional Tests

Directionality is based on Vpos divided by Ipos angle.

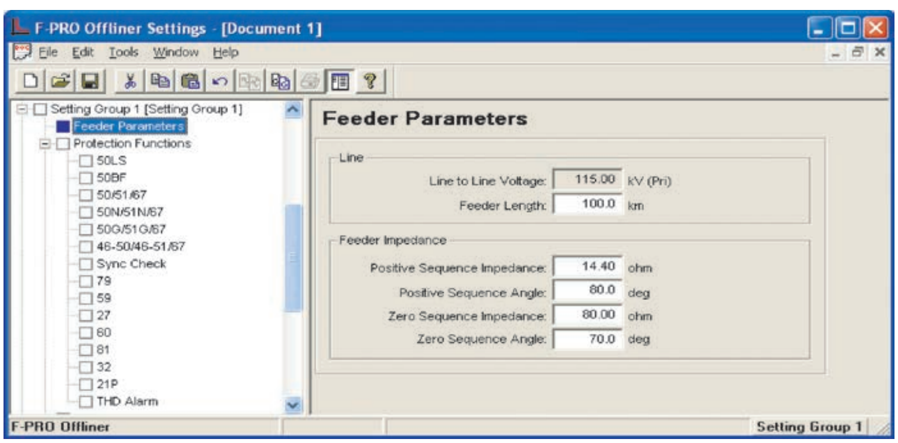


Figure 7.11: Feeder Parameter

Line Angle = 80° (i.e. current lags voltage by 80°)

Note: Required Operating Range = ±90° from line angle

46-51/67 Directional Test Procedure

1. In Relay Control Panel access relay *Metering > Logic*.

   46-51/67 Alarm

2. Apply three-phase polarizing voltage to:

Main Ph VA: 314-315: 63.5 V∠0°

Main Ph VB: 316 – 317: 63.5 V∠240°

Main Ph VC: 318 – 319: 63.5 V∠120°

3. Apply A -phase current at line angle to:

   Main Ph A: 300 – 301: 2.0 A ∠-80°

   Observe 46- 51/67 Alarm = High
4. Slowly ramp the current phase angle in negative direction (i.e. more lag):

   At -165° to -175° (expect -170°):

   46-51/67 Alarm = Low
5. Restore current to line angle (-80°):

   Observe46- 51/67 Alarm = High
6. Slowly ramp the current phase angle in positive direction (i.e. less lag):

   At +5°to +15° (expect +10°):

   46-51/67 Alarm = Low
7. Turn off voltage and current sources.

   End of 46-50/46-51/67 test

25/27/59 Sync Check Test

Note: Three or four voltage sources are required for this test.

The relay will create the positive sequence sync check voltage out of the single-phase auxiliary voltage input depending on which phase is injected.

Settings

1. Maximum voltage: 70 V sec. (Maximum Positive Sequence voltage)
2. Minimum voltage: 40 V sec. (Minimum Positive Sequence voltage)
3. Angle Difference: 20 degrees
4. Time Delay: 200 milliseconds
5. Dead Main Live Aux. (DMLA): Enable
6. Live Main Dead Aux. (LMDA): Enable
7. Dead Main Dead Aux. (DMDA): Enable

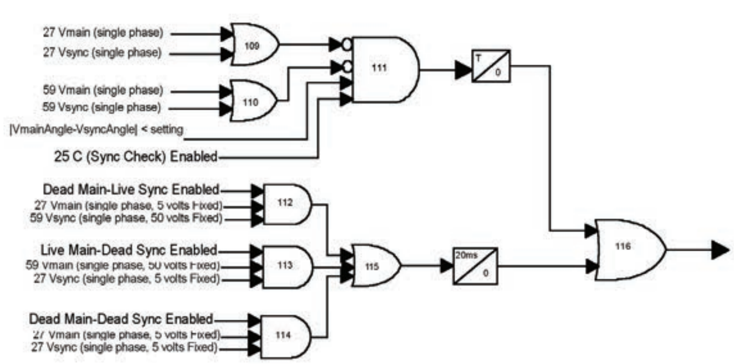


Figure 7.12: Protection Logic 25/27/59 Sync Check

Sync Check Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.
   25/27/59 Sync Check
   Output Contact: 10
   Observe 25/27/59 Sync Check = High (Proves DMDA with no voltage applied)
2. Apply voltages to the relay main voltage input terminals sufficient to create Vpos of 66.4 V.If only 3 voltage sources are available:
   Ph A: 314 – 315: 99.6 V ∠0°
   Ph B: 316 – 317: 99.6 V∠-120°
   Ph C: 318 – 319: not applicable
   OR
   If 4 voltage sources are available:
   Ph A: 314 – 315: 66.4 V ∠0°
   Ph B: 316 – 317: 66.4 V ∠240°
   Ph C: 318 – 319: 66.4 V ∠+120°
   Observe 25/27/59 Sync Check = High (Proves Live Main Dead Aux (LMDA) with only line voltage applied)
3. Turn voltage off.
4. Apply single-phase nominal voltage (20 V) to the relay auxiliary voltage input terminals.
   Apply three-phase voltage zero or below 20V (Phase to neutral)
   V synch: 320 – 321, 20 V ∠0° , Gradually increase sync voltage
   At 19.8 V to 20.5 V (expect 20.1V):
   25/27/59 Sync Check = High (Proves DMLS with only bus voltage applied)
5. Apply both sets of voltages to main and auxiliary inputs as detailed above.
   25/27/59 Sync Check = Low
   Simultaneously rotate the auxiliary voltage phase angle in lagging direction (i.e. toward 0°).
   At 21°to 19° difference (expect 20°):25/27/59 = High
   Contact 10 = Closed (after 200 ms)
6. Slowly ramp down the auxiliary voltage magnitude.
   At 41.0 to 39.0 V (expect 40 V):
   25/27/59 = Low

79 Recloser Test

Settings

Main/Aux		Enable
1.	Number of Shots	4
2.	First Reclose (T1)	2.0 seconds
3.	Second Reclose (T2)	4.0 seconds
4.	Third Reclose (T3)	6.0 seconds
5.	Fourth Reclose (T4)	8.0 seconds
6.	Close time (Tp)	0.3 seconds
7.	Fourth Reclose (T4)	8.0 seconds
8.	Close time (Tp)	0.3 second
9.	Lockout Reset (TD)	12 seconds
10.	Initiate Reset (TDI)	1.0 second
11.	Block Reset (TDB)	1.0 seconds
12.	Sync Control	Disable

50 LS-1 Main	Enabled
Gate switch	OR
Pickup	2 A
Pickup Delay	0.1 sec

79Recloser and Block are set to be initiated via the Output Matrix.

79 Reclose Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.
   50LS-1 Main Trip
   79 Intiate
   79 Main Reclose
2. Apply balanced 3-phase nominal voltages (63.5 V) & Current (1 A) to the relay terminals.
   Ph A: 300 – 301: 1.0∠-0°Main Ph A: 314 – 315: 63.5 V ∠0°
   Ph B: 302 – 303: 1.0∠240°Main Ph B: 316 – 317: 63.5 V ∠-120°
   Ph C: 304 – 305: 1.0∠120°Main Ph C: 318 – 319: 63.5 V ∠+120°
3. Increase the Main - A /B/C phase current above the setting value until

50LS-1 Main Trip becomes high.

4. Apply zero current in all three phases for 2 seconds

   After 2 secondes : Main Breaker Reclose (Shot 1,T1)

5. Apply balanced 3-phase nominal voltages (63.5) & Current (1 A) to the relay terminals for 2 seconds

6. Increase the Main - A /B/C phase current above the setting value until

   50LS-1 Main Trip becomes high.

7. Apply zero current in all three phases for 4 seconds

   After 4 secondes : Main Breaker Reclose (Shot 2,T2)

8. Apply balanced 3-phase nominal voltages (63.5) & Current (1 A) to the relay terminals for 2 seconds

9. Increase the Main - A /B/C phase current above the setting value until

   50LS-1 Main Trip becomes high.

10. Apply zero current in all three phases for 6 seconds

    After 6 secondes : Main Breaker Reclose (Shot 3,T3)

11. Apply balanced 3-phase nominal voltages (63.5) & Current (1A) to the relay terminals for 2 seconds

12. Increase the Main - A /B/C phase current above the setting value until

    50LS-1 Main Trip becomes high.

13. Apply zero current in all three phases for 8 seconds

    After 8 secondes : Main Breaker Reclose (Shot 4,T4)

14. Apply balanced 3-phase nominal voltages (63.5 V) & current (1A) to the relay terminals for 13 seconds

    Ph A: 300 – 301: 1.0∠-0°Main Ph A: 314 – 315: 63.5 V ∠0°

    Ph B: 302 – 303: 1.0∠240°Main Ph B: 316 – 317: 63.5 V ∠-120°

    Ph C: 304 – 305: 1.0∠120°Main Ph C: 318 – 319: 63.5 V ∠+120°

The following procedure allows the user to test the Main and Auxiliary 4-shot reclosers, ending in 79 lockouts.

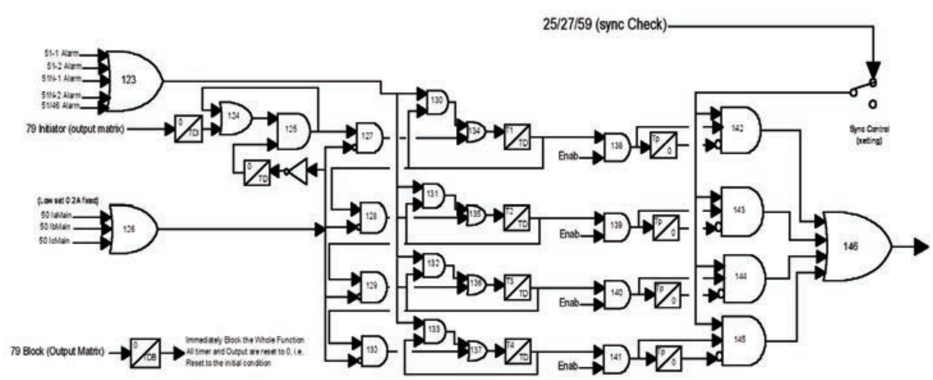


Figure 7.13: Protection Logic 79

59 - Overvoltage Test

Settings

59-1	Enable	59-2	Enable
Gate switch	OR	Gate switch	AND
Pickup	72 V	Pickup	72 V
Time Delay	0.05 second	Time Delay	0.1 second

Output Contact1 (59-1 Trip)

Output Contact2 (59-2 Trip)

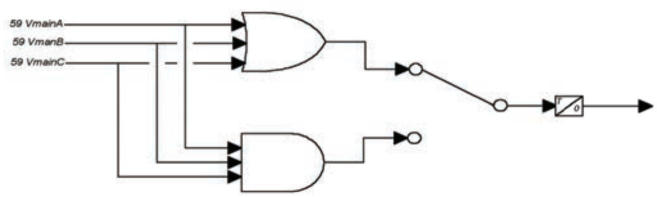


Figure 7.14: Protection Logic 59

59 Overvoltage Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.
   59 -1 Trip
   59 -2 Trip
   Output 1 (59-1Trip)
   Output 2 (59-2 Trip)
2. Apply balanced 3-phase nominal voltages (63.5 V) to the relay terminals.
   Main Ph VA: 314 – 315: 63.5 V∠0°
   Main Ph VB: 316 – 317: 63.5 V∠240°
   Main Ph VC: 318 – 319: 63.5 V∠120°
   Observe:
   59 -1 Trip = Low
   59 -2 Trip = Low
3. Increase A Phase voltage:
   At 71.5 to 72.5 V (expect 72 V):
   59 -1 Trip = High & Output Contact 1= Closed
   59 -2 Trip remains Low & Contact 2 = Open
4. With A Phase voltage still increased, increase B and C Phase V.
   At 71.5 to 72.5 V (expect 72 V):
   59 -2 Trip = High
   59 -1 Trip = High

Contact 1 = Closed

Contact 2 = Closed

End of 59 overvoltage test.

27 Undervoltage Test

Settings

27-1	Enable	27-2	Enable
Gate switch	OR	Gate switch	AND
Pickup	30 V	Pickup	30 V
Time Delay	0.05 second	Time Delay	0.1 second

Output Contact1 (27-1 Trip)

Output Contact2 (27-2 Trip)

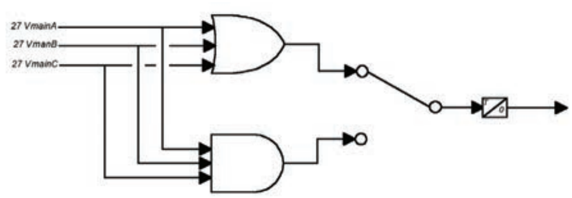


Figure 7.15: Protection Logic 27

27- Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.
   27-1 Trip
   27-2 Trip
   Monitor
   Output Contact1 (27-1 Trip)
   Output Contact2 (27-2 Trip)
2. Apply balanced 3-phase nominal voltages (66.4 V) to the relay terminals.
   Main Ph VA: 314 – 315: 63.5 V∠0°
   Main Ph VB: 316 – 317: 63.5 V∠240°
   Main Ph VC: 318 – 319: 63.5 V∠120°
   Observe:
   27 -1 Trip = Low
   27 -2 Trip = Low
3. Reduce A - Phase voltage.
   At 30.5 to 29.5 V (expect 30 V):
   27 -1 Trip = High
   Output Contact1 (27-1 Trip)

27 -2 Trip remains Low & Output Contact2 Open

4. With A - Phase voltage still reduced, reduce B and C phase V

   At 30.5 to 29.5 V (expect 30 V):

   27 -1 Trip = High

   27 -2 Trip = High

   Output Contact1 (27-1 Trip) = Closed

   Output Contact2 (27-2 Trip) = Closed

   End of 27 Undervoltage test.

60 Loss of Potential (LOP) Test

Settings

1. Voltage = 0.5 per unit phase to netrual fixed

   (In this case minimum operate = $0.5*V_{Nominal}$ = 0.5*63.5 =31.75 V)

2. Pick up time delay = 10 Seconds (Fixed)

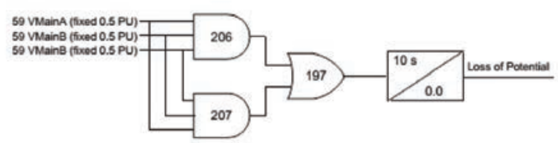


Figure 7.16: Protection Logic LOP

60 Loss of Potential (LOP) Test Procedure

1. In Relay Control Panel access *Metering* > *Logic*.

   60 alarm

2. Apply balanced 3-phase nominal voltages at nominal frequency to the FPRO terminals.

   Main Ph A: 314 – 315: 63.5 V ∠0°

   Main Ph B: 316 – 317: 63.5 V ∠-120°

   Main Ph C: 318 – 319: 63.5 V ∠+120°

3. Instantaneously reduce single phase or two phases voltage to 31.75 or less and ensure 60 Alarm is high in RCP metering

   End of 60 Loss of Potential (LOP) test.

81- Overfrequency and Underfrequency Test Procedure

Settings:

1. 81-1 Pickup = 60.5 Hz Fixed Rate (50.5 Hz for 50 Hz Relay)
   81-1 Time Delay = 0.5 second
2. 81-2 Pickup = 59.5 Hz Fixed Rate (49.5 Hz for 50 Hz Relay)
   81-2 Time Delay = 0.5 second
3. 81-3 Pickup = +1.0 Hz/second
   81-3 Time Delay = 0.2 second
4. 81-4 Pickup = -1.0 Hz/second
   81-4 Time Delay = 0.2 second

Requires minimum of 0.25 per unit positive sequence voltage (fixed setting) to enable the 81 element

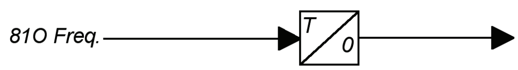


Figure 7.17: Protection Logic 81

81- Fixed Rate Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.
   Monitor:
   81-1 Trip
   81-2 Trip
2. Apply balanced 3-phase nominal voltages at nominal frequency to the F-PRO terminals.
   Main Ph A: 314 – 315: 66.4 V ∠0°
   Main Ph B: 316 – 317: 66.4 V ∠-120°
   Main Ph C: 318 – 319: 66.4 V ∠+120°
   81-1 Trip = Low
   81-2 Trip= Low
3. Ramp up the voltage frequency.
   At 60.499 to 60.501 Hz (50.499 to 50.501 Hz for 50 Hz relay):
   81-1 = High
   81-2 = Low
   Contact 8 = Closed
4. Ramp down the voltage frequency.
   At 59.501 to 59.499 Hz (49.501 to 49.499 Hz for 50 Hz Relay):
   81-1 = Low
   81-2 = High
   Contact 9 = Closed
5. Turn voltage source off.

81 Rate of Change ($df/ddf/d$t) Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.

   Monitor:

   81-3 Trip

   Contact: 10

2. Apply balanced 3-phase nominal voltages at nominal frequency to the FPRO terminals.

   Main Ph A: 314 – 315: 66.4 V ∠0°

   Main Ph B: 316 – 317: 66.4 V ∠-120°

   Main Ph C: 318 – 319: 66.4 V ∠+120°

   81-3 = Low

   81-4 = Low

3. Ramp the frequency at a rate of +0.99 Hz/s for duration of 2 seconds.

   81-3 = Low

   81-4 = Low

   Contact 9 = Open

4. Restore nominal frequency.
5. Ramp the frequency at a rate of +1.01 Hz/s for duration of 2 seconds.

   81-3 = High

   81-4 = Low

   Contact 9 = Closed

6. Restore nominal frequency.
7. Ramp the frequency at a rate of -0.99 Hz/s of duration of 2 seconds.

   81-3 = Low

   81-4 = Low

   Contact 9 = Open

8. Restore nominal frequency.
9. Ramp the frequency at a rate of -1.01 Hz/s for duration of 2 seconds.

   81-3 = Low

   81-4 = High

   Contact 9 = Closed

81 - Timing Test Procedure

1. Monitor (Timer Stop) on Output Contact 8 (81-1).
2. Set timer start on instantaneous frequency shift 66.4 V @ 60 Hz to 60.6 Hz transition.

   Expect time delay of 500 ms + approximately 1.5 cycle detection time.

3. Apply the frequency shift.

   Confirm the expected time delay.

   Target “81-1”

4. Move (Timer Stop) to Output Contact 9 (81-2).

5. Set timer start on instantaneous frequency shift 66.4 V @ 60 Hz to 59.4 Hz transition.

   Expect time delay of 500 ms + approximately 1.5 cycle detection time.

6. Apply the frequency shift.

   Confirm the expected time delay.

   Target "81-2"

   End of 81- test.

Device 32P and 32Q (Directional Power Protection)

32P Settings Parameters

32P	Enable
Pickup	3.0 A (real)
Pickup delay	2.00 sec

32P - Test Procedure

This function takes the pickup value of current based on the following formula:

Pickup = I * cos∅

By default, the function assumes the value of cos∅ as 1 (i.e.) unity power factor.

If we have to test for other power factors (leading or lagging), we have to input the pickup value in terms of unity power factor only.

Eg: Assume

Leading power factor of = cos(30) = 0.866

Pickup setting = 3 A

So to test for this setting, we need to inject the following value of current

$3 = I_{test} * 0.866$

$I_{test} = 3/0.866 = 3.464$ A

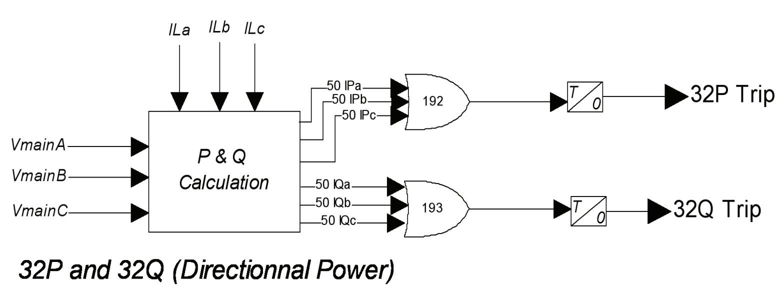


Figure 7.18: Protection Logic 32P & 32Q

Pickup Test

1. Apply balanced 3-phase nominal current (1.0 A) to the relay terminals.
   Main Ph A: 300 – 301: 1.0∠0°
   Main Ph B: 302 – 303: 1.0∠240°
   Main Ph C: 304 – 305: 1.0∠120°
   Main Ph VA: 314 – 315: 63.5∠0°
   Main Ph VB: 316 – 317: 63.5∠240°
   Main Ph VC: 318 – 319: 63.5∠120°
2. Increase the A Phase current gradually
   At 2.90 to 3.15 A (expect 3 A)
3. The same procedure is followed for reactive power settings (I * sin∅) Import and export depends upon our relay settings
4. End of 81- test.

21P – Phase Distance

Setting

21P-1	Enable
Forward reach	5.39 Ω
Delta current Supervision	0.20 A
21P-2	Enable
Forward reach	5.39 Ω
Delta current Supervision	0.20 A
Assign Output contact via ProLogic's	
Output Contact1	21P-1 Trip
Output Contact2	21P-2 Trip

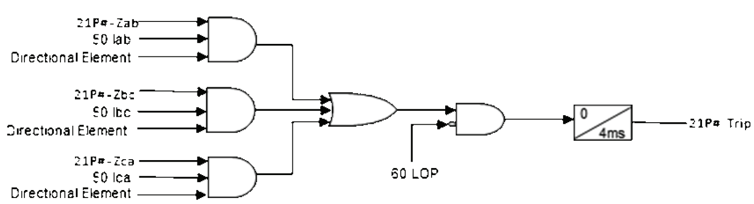


Figure 7.19: Protection Logic 21P

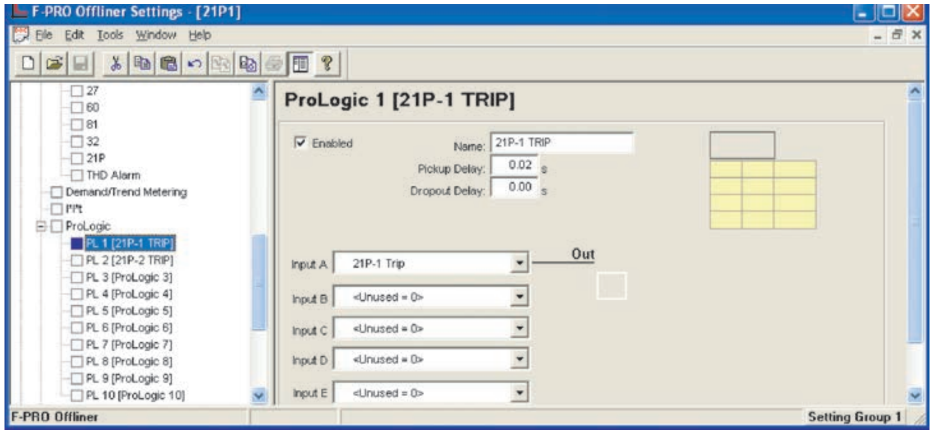


Figure 7.20: ProLogic

21P Test Procedure

1. In Relay Control Panel access relay *Metering* > *Logic*.

   21P1 Zone 1Trip

2. Apply balanced 3-phase nominal voltages (63.5 V) & Current (1A) to the relay terminals.

   Ph A: 300 – 301: 1.0∠-0°Main Ph A: 314 – 315: 63.5 V ∠0°

   Ph B: 302 – 303: 1.0∠240°Main Ph B: 316 – 317: 63.5 V ∠-120°

   Ph C: 304 – 305: 1. 0∠120°Main Ph C: 318 – 319: 63.5 V ∠+120°

   21P1 Trip = Low

   21P2 Trip = Low

3. Simultaneously reduce 2-phase voltages.

   Ph A: 300 – 301: 2.0∠-80°Main Ph A: 314 – 315: 9 V ∠0°

   Ph B: 302 – 303: 2.0∠100°Main Ph B: 316 – 317: 9 V ∠-120°

   Ph C: 304 – 305: 0.0∠120°Main Ph C: 318 – 319: 63.5 V ∠+120°

   21P1 Trip =High

   21P2 Trip = High

4. End of 21P- test

THD Alarm Function

Settings

THD Alarm Pickup: 20%

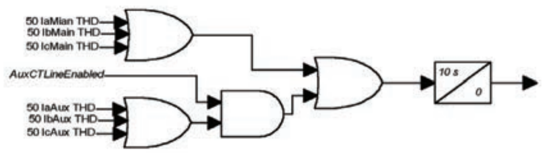


Figure 7.21: Protection Logic THD

As shown in Figure 7.21: Protection Logic THD on page 7-31, map the THD Alarm to Output 8 in the Output Matrix

For testing THD, use the fundamental with one harmonic from 2^{nd} to 25th. In this case the F-PRO uses the following formula for calculating Total Harmonic Distortion:

$$\text{THD\%} = 100 \text{ x } \quad \frac{\sqrt{\sum_{2}^{25} \mathrm{I}^2 \mathrm{n}}}{I\ fundamental} \quad \frac{\sqrt{\sum_{2}^{25} \mathrm{I}^2 \mathrm{n}}}{I\ fundamental} = 100$$

$$\text{x} \quad \frac{\sqrt{Iharmonics^2}}{I\ fundamental} \quad \frac{\sqrt{Iharmonics^2}}{I\ fundamental} = 100$$

$$\text{x} \quad \frac{\sqrt{Iharmonics}}{I\ fundamental} \quad \frac{\sqrt{Iharmonics}}{I\ fundamental}$$

THD Test Procedure

1. Access Relay Control Panel, *Metering* > *Logic* or Front HMI, *Metering* > *Logic*.

   THD Alarm
2. Apply parallel currents to terminals 300 – 301 as follows:

   Source 1 (Fundamental 60 Hz): 2.0 A ∠0° (Terminals 300 – 301)

   Source 2 (2ndHarmonic 120 Hz): 0.0 A ∠0° (Super impose the 2ndHarmonic)
3. Slowly ramp Source 2 up.

   At 0.19 to 0.21 A (expect 0.20 A)

THD Alarm = High

After 10 seconds:

Contact 8 = Closed

4. End of THD test.

Demand/Trend Metering

Settings

Demand Meter Interval (minutes)	5
Demand Meter Type	Integrating

Demand/Trend Metering Test Procedure

1. Access Relay Control Panel, *Metering* > *Demand* or Front HMI, *Metering* > *Demand*.
2. Apply balanced 3-phase nominal voltages (63.5 V) & Current (1 A) to the relay terminals.

   Ph A: 300 – 301: 1.0∠-0°Main Ph A: 314 – 315: 63.5 V ∠0°

   Ph B: 302 – 303: 1.0∠240°Main Ph B: 316 – 317: 63.5 V ∠-120°

   Ph C: 304 – 305: 1. 0∠120°Main Ph C: 318 – 319: 63.5 V ∠+120°
3. Wait for the next 5 minutes

   After the settled time it will display the respective applied values
4. End of Demand/Trend Metering test.

I*I*t

Settings

External Input or Pro Logic for trip	Enable
I*I*t Limit	40 (KA)^2*S
CT Ratio	1000/1

I*I*t Test Procedure

1. Access Relay Control Panel, *Metering* > *I*I*t* or Front HMI, *Metering* > *I*I*t* or *Relay Control Panel* > *Events*.
2. Apply balanced 3-phase Current (1A) to the relay terminals.

   Ph A: 300 – 301: 1.0∠-0°

   Ph B: 302 – 303: 1.0∠240°

   Ph C: 304 – 305: 1. 0∠120°
3. Enable and Disable the External Input or Pro logic for trip in regular 20s intervals.

   At 39 Sec to 41 Sec (expect 40 Sec):

After the settled limit it will display the respective values in Relay control panel Events

4. End of I*I*t test.

8 Installation

8.1 Introduction

This section deals with the installation of the F-PRO relay when first delivered. The section covers the physical mounting, AC and DC wiring and the Communication wiring.

8.2 Physical Mounting

Standard 3U

The relay is 3 rack units or 5.25 inches high and approximately 12.9 inches deep. The standard relay is designed for a 19-inch rack. A complete mechanical drawing is shown, for details see “Mechanical Drawings” in Appendix G

To install the relay the following is needed:

- 19 inch rack
- 4 - #10 screws

8.3 AC and DC Wiring

For details see “AC Schematic Drawing” in Appendix I and “DC Schematic Drawing” in Appendix J.

8.4 Communication Wiring

EIA-232

The relay’s serial ports (Ports 122 and 123) are configured as EIA RS-232 Data Communications Equipment (DCE) devices with female DB9 connectors. This allows them to be connected directly to a PC serial port with a standard straight-through male-to-female serial cable. Shielded cable is recommended, for pin-out see “Communication Port Details” on page 2-15.

An adapter is available for connecting an external modem to Port 123 for details see “Modem Link” on page 2-7.

RJ-45

There is one front and one or two rear 100BASE-T Ethernet Port 119 and 120 with RJ-45 receptacle. Use CAT5 or CAT5e straight. The rear Ethernet Port 119 and 120 may also be configured as a 100BASE- Fx optical port.

Optical ST

Port 119 and 120 in the rear panel may also be configured with ST style optical connectors if desired. These are 1300 nm 100BASE-FX optical ports. The transmit and receive connections are indicated on the rear panel. Use standard multi-mode cables with ST connectors for this interface.

USB

Port 150 on the front panel is a standard USB-B connector. This port is the Maintenance port of the relay. This is a USB 2.0 Full Speed interface and can be connected to a PC with a standard USB peripheral cable (A style to B style).

RJ-11

The relay may have an optional internal modem. Connection to this is via the relay's Port 118 RJ-11 receptacle. A standard telephone extension cable is to be used.

IRIG-B Wiring

Port 121 on the rear panel accepts both modulated and unmodulated IRIG-B standard time signals with or without the IEEE 1344 extensions. The IRIG-B connector on the back of the relay is BNC type.

Appendix A IED Specifications

F-PRO Model 4000 Specifications		
Item	**Quantity/Specs**	**Note**
General:		
Nominal Frequency	50 or 60 Hz	
Memory	Settings and records are stored in non-volatile memory	Records are stored in a circular buffer
Power Supply	43 – 275 Vdc, 90 – 265 Vac, 50/60 Hz	Power Consumption: 25 – 30 VA (ac) 25 – 30 W (dc)
Protection Functions:		
IEEE Device 50LS, 50BF, 50/51/67, 50N/51N/67, 46-50/46-51/67, 50G/51G/67, 25/27/59 (25C), 21P, 59, 27, 32(P&Q), 60, 79, 81, and THD	2 x 3-phase current inputs (6 current channels) 1 x 3-phase voltage inputs (3 voltage channels) 1 x 1-phase voltage input for sync check 1 x 1-phase current input for Measured Earth fault	Ring bus configuration and integrated HV breaker auto-recloser
ProLogic	10 statements per setting group, breaker logic	5 inputs per ProLogic^{TM} statement, 4 timers/statement
Setting Groups	8 (16 group logic statements per setting group)	Total: 128 group logic statements
Recording:		
Transient (Fault)	96 s/c oscillography of all analog and external input digital channels	User-configurable 0.2 to 2.0 seconds Record length and 10cycles pre-fault length
Trend	Demand metering: trending, integrating, rolling, thermal modes Demand interval: 5 – 60 minutes @ 5 minute increments Trending: 30 to 360 days	Trend auto save
Events	250 events circular log with 1ms resolution I*I*t: trigger by user defined event and/or trip	When event auto save is enabled, a compressed event record is created every 250 events.
Record Capacity	75 records of transient and optionally event records.	

F-PRO Model 4000 Specifications

Input & Output:		
Analog Voltage Inputs 1 set of 3-phase voltage inputs per relay (3 voltage channels) 1 set single-phase positive sequence voltage	Nominal Voltage Continuous rating over voltage Maximum over-scale thermal rating Burden	Vn = 69 Vrms 2x Vn = 138 Vrms 3x Vn = 207 Vrms for 10 seconds <0.15 VA @ 69 Vrms
Analog Current Inputs 2 sets of 3-phase current inputs (6 current channels) 1 set of 1 phase current input	Nominal Current Full Scale/Continuous Maximum full-scale rating Thermal rating Burden	In = 1 Arms or 5 Arms 3x In = 3 Arms or 15 Arms 40x In for 1 second symmetrical 400 Arms for 1 second <0.25 VA @ 5 Arms
Analog Sampling Rate	96 samples/cycle for recording 8 samples/cycle for protection	Records up to 25th harmonic
External Inputs (digital)	9 isolated inputs	Optional 48, 110/125 or 220/250 Vdc nominal, externally wetted
Isolation	2 kVrms	
Output Relays (contacts)	14 programmable outputs and 1 relay inoperative output (N.C.))	Externally wetted Make: 30 A as per IEEE C37.90 Carry: 8 A Break: 0.9 A at 125 Vdc resistive 0.35 A at 250 Vdc resistive
Virtual Inputs	30 Virtual Inputs	
Amplitude measurement accuracy	+/-0.5% for 44 to 66 Hz	
Interface & Communication:		
Front Display	240 x128 pixels graphics LCD	
Front Panel Indicators	16 LEDs: 11 programmable, 5 fixed	Fixed: Relay Functional, IRIG-B Functional, Service Required, Test Mode, Alarm Target (11 programmable)
Front User Interface	USB port and 100BASE-T Ethernet port	Full Speed USB 2.0, RJ-45
Rear User Interface	LAN Port 1: 100BASE Copper or Optical 1300nm LAN Port 2: 100BASE Copper or Optical Two Serial RS-232 ports to 115 kbd modem	Copper: RJ-45, 100BASE-T Optical: 100BASE-FX, Multimode ST style connector Com port can support external modem
Internal Modem	33.6 Kbps, V.32 bis	Optional internal modem
SCADA Interface	IEC61850 (Ethernet) or DNP3 (RS-232 or Ethernet) or Modbus (RS-232)	Rear port
Time Sync	IRIG-B, BNC connector B003,B004,B123 and B124 Time Codes	Modulated or unmodulated, auto-detect
Self Checking/Relay Inoperative	1 contact	Closed when relay inoperative

F-PRO Model 4000 Specifications

Environmental:		
Ambient Temperature Range	-40°C to 85°C for 16 hours -40°C to 70°C continuous	IEC 60068-2-1/IEC 60068-2-2 LCD contrast impaired for temperatures below -20°C and above 70° C
Humidity	Up to 95% without condensation	IEC 60068-2-30
Insulation Test (Hi-Pot)	Power supply, analog inputs, external inputs, output contacts – 2 kVrms, 50/60 Hz, 1 minute	IEC 60255-5, ANSI/IEEE C37.90
Electrical Fast Transient	Tested to level 4 - 4.0 kV 2.5/5 kHz on Power and I/O lines	ANSI/IEEE C37.90.1, IEC/EN 60255-22-4, IEC 61000-4-4
Oscillatory Transient	Test level = 2.5kV	ANSI/IEEE C37.90.1, IEC/EN 60255-22-1, IEC61000-4-12 Level 3
RFI Susceptibility	10 V/m modulated, 35 V/m unmodulated	ANSI/IEEE C37.90.2, IEC 60255-22-3, IEC 61000-4-3 Level 3
Conducted RF Immunity	150 kHz to 80 MHz	IEC 60255-22-6 / IEC 61000-4-6 Level 3 / IEC 61000-4-16 Level 4
Shock and Bump	5 g and 15 g	IEC 60255-21-2, IEC/EN 60068-2-27: Class 1
Sinusoidal Vibration	1g, 10 Hz to 150 Hz, 1.0 octave/min, 40 sweeps	IEC/EN 60255-21-1, IEC/EN 60068-26, Class 1
Voltage Interruptions	200 ms interrupt	IEC 60255-11 / IEC 61000-4-11
Physical:		
Weight	9.55 Kg	21.0 lbs
Dimensions	13.2 cm height x 48.26 cm width rack mount x 32.8 cm depth	5.2 height x 19 width rack mount x 12.9 depth
Time Synchronization and Accuracy		
External Time Source	Synchronized using IRIG-B input (modulated or unmodulated) auto detect	In the absence of an external time source, the relay maintains time with a maximum 90 seconds drift per year at a constant temperature of 25C. The relay can detect loss of re-establishment of external time source and automatically switch between internal and external time.
Synchronization Accuracy	Sampling clocks synchronized with the time source (internal or external)	

F-PRO Model 4000 Specifications	
Overall F-PRO Accuracies	
Current	±2.5% of inputs from 0.1 to 1.0 x nominal current (I_n)
	± 1.0% of inputs from 1.0 to 40.0 x nominal current (I_n)
Voltage	± 1.0% of inputs from 0.01 to 2.0 x nominal voltage (V_n)
Impedance	±5.0% or 5 mΩ of set value from 0.05 to 66.00 ohms secondary (0.25 to 330.00 ohms secondary, 1 A nominal)
Directional Phase Angle	±2.0° of set value of Positive Sequence Line Angle value from 25.0° to 89.0°
Frequency Elements	±0.001 Hz (fixed level)
	±0.05 Hz (df/dt)
Sync Check Elements	±0.2 degrees
Timers	±3 ms of set value
Inverse Overcurrent Timers	±2.5% or ±1 cycle of selected curve
Definite Overcurrent Timers	±2.5% or ±1 cycle non-directional
	±2.5% or ±1.5 cycle directional
Frequency Timer	±2.5% of set value plus 1.25 cycles to 1.75 cycles of inherent delay (fixed level) at 2x pickup, error <40 ms (df/dt) at 0.1 Hz/s above pickup, error <100 ms

F-PRO Model 4000 Specifications			
Detailed Environmental Tests			
Test	**Description**		**Test Level**
	Type Test	**Test Points**	
FCC Part 15	RF emissions	Enclosure ports	Class A: 30 - 1000 MHz
	Conducted emissions	ac/dc power ports	Class A: 0.15 - 30 MHz
IEC/EN 60255-25	RF emissions	Enclosure ports	Class A: 30 - 1000 MHz
	Conducted emissions	ac/dc power ports	Class A: 0.15 - 30 MHz
IEC/EN 61000-3-2	Power line harmonics	ac power port	Class D: max.1.08, 2.3, 0.431.14, 0.3, 0.77, 0.23 A.... for 2nd to nth harmonic
IEC/EN 61000-3-3	Power line fluctuations	ac power port	THD/ 3%; Pst <1., Plt < 0.65
		dc power port	N/A
IEC/EN 61000-4-2	ESD	Enclosure contact	+/- 6 kV
IEC/EN 60255-22-2		Enclosure air	+/- 8 kV

F-PRO Model 4000 Specifications			
Detailed Environmental Tests			
IEEE C37.90.3	ESD	Enclosure contact	+/- 8 kV
		Enclosure air	+/- 15 kV
IEC/EN 61000-4-3	Radiated RFI	Enclosure ports	10 V/m: 80 - 1000 MHz
IEC/EN 60255-22-3			
IEEE C37.90.2	Radiated RFI	Enclosure ports	35 V/m: 25 - 1000 MHz
IEC/EN 61000-4-4	Burst (fast transient)	Signal ports	+/- 4 kV @2.5 kHz
IEC/EN 60255-22-4		ac power port	+/- 4 kV
IEEE C37.90.1		dc power port	+/- 2kV L-PE, +/- 1kV L-L
		Earth ground ports	+/- 4 kV
IEC/EN 61000-4-5	Surge	Communication ports	+/- 1kV L-L
IEC/EN 60255-22-5		ac power port	:+/- 2kV L-PE, +/- 1kV L-L
		dc power port	+/- 2kV L-PE, +/- 1kV L-L
IEC/EN 61000-4-6	Induced (conducted) RFI	Signal ports	10 Vrms: 0.150 - 80 MHz
IEC/EN 60255-22-6		ac power port	10 Vrms: 0.150 - 80 MHz
		dc power port	10 Vrms: 0.150 - 80 MHz
		Earth ground ports	10 Vrms: 0.150 - 80 MHz
IEC/EN 60255-22-7	Power frequency	Binary input ports: Class A	Differential = 150 Vrms
			Common = 300 Vrms
IEC/EN 61000-4-8	Magnetic leld	Enclosure ports	40 A/m continuous, 1000 A/m for 1 s
IEC/EN 61000-4-11	Voltage dips & interrupts	ac power port	30% for 1 period, 60% for 50 periods
			100% for 5 periods, 100% for 50 periods
		dc power port	30% for 0.1 s, 60% for 0.1 s,
			100% for 0.05 s
IEC 60255-11	Voltage dips & interrupts	dc power port	100% reduction for up to 200 ms
IEC/EN 61000-4-12	Damped oscillatory	Communication ports	1.0 kV Common, 0 kV Diff
IEC/EN 60255-22-1		Signal ports	2.5 kV Common, 1 kV Diff
		ac power port	2.5 kV Common, 1 kV Diff
		dc power port	2.5 kV Common, 1 kV Diff
IEEE C37.90.1	Oscillatory	Signal ports	2.5 kV Common, 0 kV Diff
		ac power port	2.5 kV Common, 0 kV Diff
		dc power port	2.5 kV Common, 0 kV Diff

F-PRO Model 4000 Specifications			
Detailed Environmental Tests			
IEC/EN 61000-4-16	Mains frequency voltage	Signal ports	30 V continuous, 300 V for 1s
		ac power port	30 V continuous, 300 V for 1s
IEC/EN 61000-4-17	Ripple on dc power supply	dc power port	1000%
Note:The F-PRO 4000 is available with 5 or 1 amp current input. All current specifications change accordingly.			

A.1 Distance Element Operating Time Curves at Nominal Frequency

Figure A.1: shows the operating times for the F-PRO Relay distance elements.

The diagrams show operating times at each test point including output contact operate time.

Faults were applied at a location representing a percentage of the Zone 1 relay reach setting.

Tests were performed for source impedance ratios (SIR) of 0.1, 1.0, 10.0, and 30.0.

No pre-trigger load current or fault resistance was included. Operating times are the same for both 50 Hz and 60 Hz.

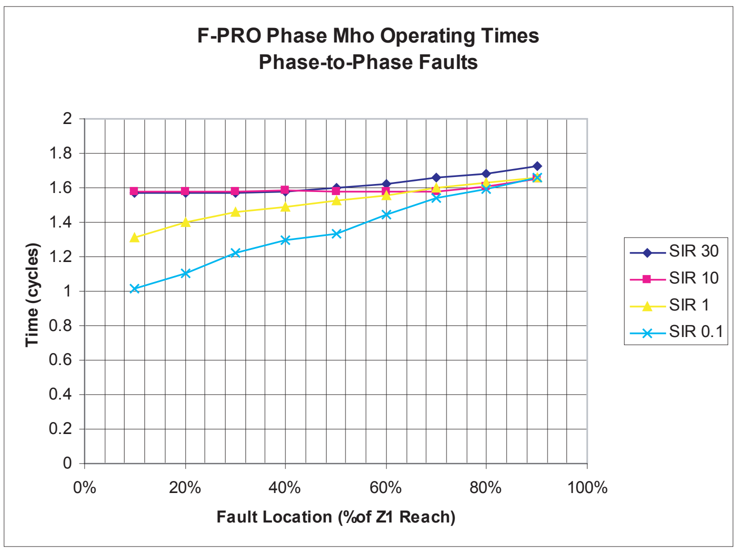


Figure A.1: Phase Mho Operating Times Phase-to-Phase Faults

A.2 Frequency Element Operating Time Curves

Figure A.2: Time delay Error at .2 Seconds, Figure A.3: Time Delay Error at 1 Second and Figure A.4: Time Delay Error at 10 Seconds show operating times for the F-PRO frequency rate of change elements at different time delay settings and rate of change settings.

The diagrams show operating times at each test point including output contact operate time. Operating times are the same for both 50 Hz and 60 Hz.

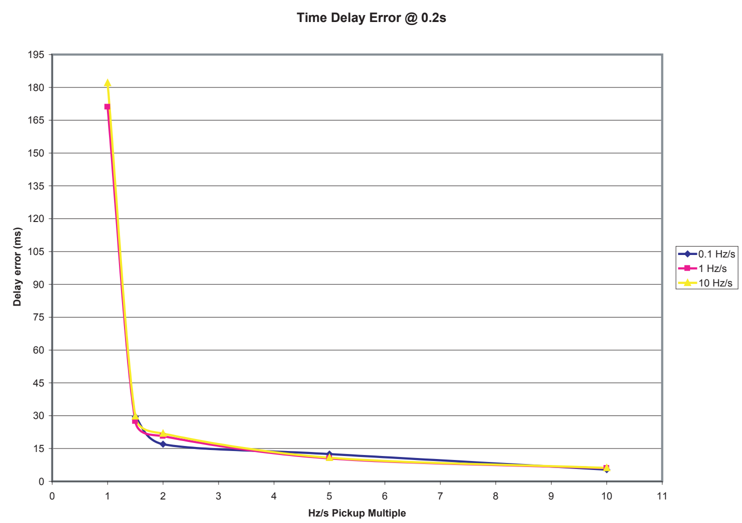


Figure A.2: Time delay Error at .2 Seconds

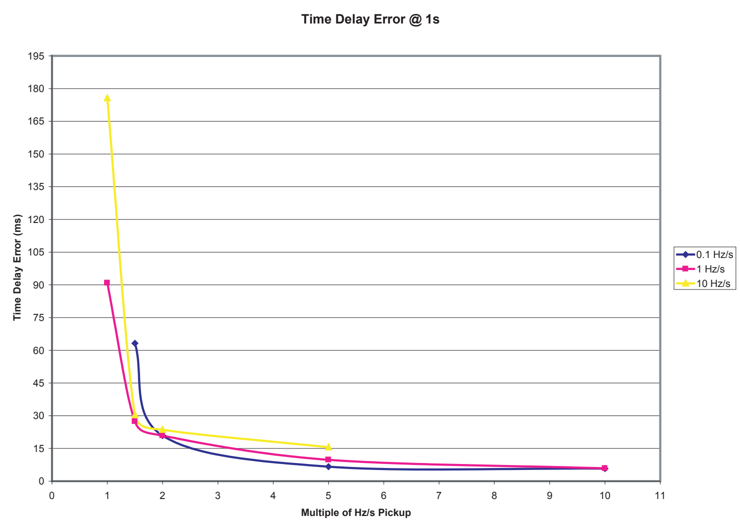


Figure A.3: Time Delay Error at 1 Second

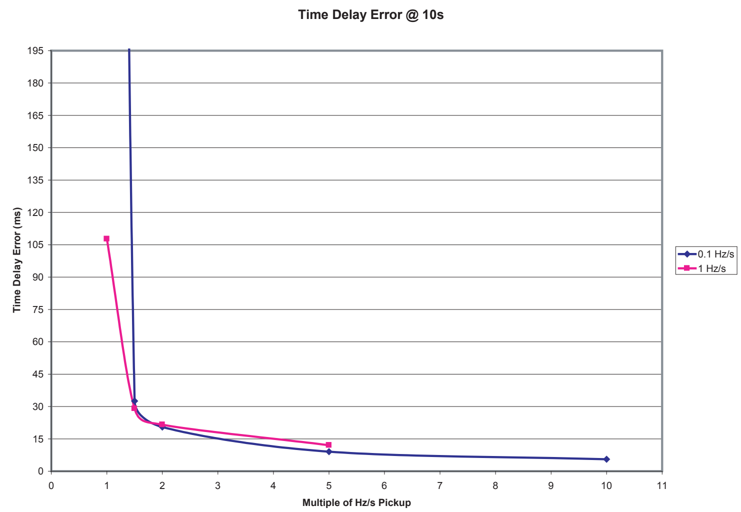


Figure A.4: Time Delay Error at 10 Seconds

Appendix B IED Settings and Ranges

When a setting has been completed in the F-PRO Offliner Settings software, it can be printed along with the ranges available for these settings. This is a view only option, that is, if you want to change settings you must go back into the settings portion dealing with that setting to make changes. The summary is however, a quick way of having a look at all the settings in a very compact form.

The top part of the settings summary identifies the date that the settings were done, the relay identification, the station that the relay is applied and the location.

The setting summary provides a list of all the current and voltage analog input quantity names used for line protection and used for recording. External Inputs and Output contact names are also identified on this summary.

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Relay Identification			
Settings Version	401		
Ignore Serial Number	No		
Serial Number	FPRO-4000-000615-01		
Unit ID	UnitID		
Nominal CT Secondary Current	5:00 AM		
Nominal System Frequency	60 Hz		
Comments	Comments		
Setting Name	Default Settings		
Date Created-Modified	10/4/1999 16:21		
Station Name	Station Name		
Station Number	1		
Location	Location		
Line	D245		
Setting Group 1 [Setting Group 1]			
Setting Group Comments:			
Analog Input Names			
MVA	Main Voltage A		
MVB	Main Voltage B		
MVC	Main Voltage C		
IA1	Main Current A		
IB1	Main Current B		
IC1	Main Current C		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
IA2	Aux Current A		
IB2	Aux Current B		
IC2	Aux Current C		
SV (Sync Voltage)	Sync Voltage		
IGnd (IGND Current)	Measured E/F Current		
External Input Names			
1	EI Spare 1		
2	EI Spare 2		
3	EI Spare 3		
4	EI Spare 4		
5	EI Spare 5		
6	EI Spare 6		
7	EI Spare 7		
8	EI Spare 8		
9	EI Spare 9		
Output Contact Names			
Output 1	Out Spare 1		
Output 2	Out Spare 2		
Output 3	Out Spare 3		
Output 4	Out Spare 4		
Output 5	Out Spare 5		
Output 6	Out Spare 6		
Output 7	Out Spare 7		
Output 8	Out Spare 8		
Output 9	Out Spare 9		
Output 10	Out Spare 10		
Output 11	Out Spare 11		
Output 12	Out Spare 12		
Output 13	Out Spare 13		
Output 14	Out Spare 14		
Virtual Input Names			
VI 1	Virtual Input 1		
VI 2	Virtual Input 2		
VI 3	Virtual Input 3		
VI 4	Virtual Input 4		
VI 5	Virtual Input 5		
VI 6	Virtual Input 6		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
VI 7	Virtual Input 7		
VI 8	Virtual Input 8		
VI 9	Virtual Input 9		
VI 10	Virtual Input 10		
VI 11	Virtual Input 11		
VI 12	Virtual Input 12		
VI 13	Virtual Input 13		
VI 14	Virtual Input 14		
VI 15	Virtual Input 15		
VI 16	Virtual Input 16		
VI 17	Virtual Input 17		
VI 18	Virtual Input 18		
VI 19	Virtual Input 19		
VI 20	Virtual Input 20		
VI 21	Virtual Input 21		
VI 22	Virtual Input 22		
VI 23	Virtual Input 23		
VI 24	Virtual Input 24		
VI 25	Virtual Input 25		
VI 26	Virtual Input 26		
VI 27	Virtual Input 27		
VI 28	Virtual Input 28		
VI 29	Virtual Input 29		
VI 30	Virtual Input 30		
Setting Group Names			
Setting Group 1	Setting Group 1		
Setting Group 2	Setting Group 2		
Setting Group 3	Setting Group 3		
Setting Group 4	Setting Group 4		
Setting Group 5	Setting Group 5		
Setting Group 6	Setting Group 6		
Setting Group 7	Setting Group 7		
Setting Group 8	Setting Group 8		
System Parameters			
Base MVA	100	MVA Pri	1.0 to 1000.0
Phase Rotation	ABC		
Ring Bus Configuration (Aux CT Line Input)	Disabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Main CT Turns Ratio	240	:1	1.0 to 30000.0
Aux CT Turns Ratio	240	:1	1.0 to 30000.0
IGnd CT Turns Ratio	240	:1	1.0 to 30000.0
Main PT Turns Ratio	1000	:1	1.0 to 20000.0
Sync PT Turns Ratio	1000		1.0 to 20000.0
Sync PT Phase	0° degrees		
Line to Line Voltage	115	kV	1.00 to 2000.00
Distance Unit Selection	km		
Record Length			
Fault Record Length	0.5	seconds	0.2 to 2.0
Trend Auto Save	Disabled		
Event Auto Save	Disabled		
Feeder Parameters			
Feeder Length	100	km	0.5 to 1000.0
Positive Sequence Impedance	14.4	ohms	0.05 to 66.00
Positive Sequence Angle	80	degrees	5.0 to 89.0
Zero Sequence Impedance	80	ohms	0.05 to 200.00
Zero Sequence Angle	70	degrees	5.0 to 89.0
Protection Functions			
50LS-1 Main	Disabled		
50LS-1 Aux	Disabled		
50LS-2 Main	Disabled		
50LS-2 Aux	Disabled		
50BF Main	Disabled		
50BF Aux	Disabled		
50/67	Disabled		
51/67	Disabled		
50N/67	Disabled		
51N/67	Disabled		
50G-1/67	Disabled		
50G-2/67	Disabled		
51G/67	Disabled		
46-50/67	Disabled		
46-51/67	Disabled		
25 Sync Check	Disabled		
25 Dead Main Live Sync	Disabled		
25 Live Main Dead Sync	Disabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
25 Dead Main Dead sync	Disabled		
79 Main	Disabled		
79 Aux	Disabled		
59-1	Disabled		
59-2	Disabled		
27-1	Disabled		
27-2	Disabled		
60	Disabled		
81-1	Disabled		
81-2	Disabled		
81-3	Disabled		
81-4	Disabled		
32 P	Disabled		
32 Q	Disabled		
21P-1	Disabled		
21P-2	Disabled		
THD	Disabled		
50LS - Low Set Overcurrent			
50LS-1 Main	Disabled		
Gate Switch	OR		
Pickup	50	amperes	0.10 to 150.00
Pickup Delay	0.1	seconds	0.00 to 99.99
50LS-2 Main	Disabled		
Gate Switch	OR		
Pickup	50	amperes	0.10 to 150.00
Pickup Delay	0.1	seconds	0.00 to 99.99
50LS-1 Aux	Disabled		
Gate Switch	OR		
Pickup	50	amperes	0.10 to 150.00
Pickup Delay	0.1	seconds	0.00 to 99.99
50LS-2 Aux	Disabled		
Gate Switch	OR		
Pickup	50	amperes	0.10 to 150.00
Pickup Delay	0.1	seconds	0.00 to 99.99
50BF - Breaker Failure			
50BF Main	Disabled		
Pickup Delay 1	0.2	seconds	0.01 to 99.99

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Pickup Delay 2	0.2	seconds	0.01 to 99.99
Breaker Current Pickup	1	amperes	0.10 to 50.00
50BF Aux	Disabled		
Pickup Delay 1	0.2	seconds	0.01 to 99.99
Pickup Delay 2	0.2	seconds	0.01 to 99.99
Breaker Current Pickup	1	amperes	0.10 to 50.00
50/51/67 - Phase Overcurrent			
50/67	Disabled		
Directional Control	forward		
Pickup	50	amperes	0.25 to 150.00
Pickup Delay	1	seconds	0.01 to 99.99
51/67	Disabled		
Directional Control	forward		
Pickup	7.5	amperes	0.25 to 50.00
Curve Type	IEC standard inverse		
TMS	1	-	0.01 to 10.00
A	0.14	-	-
B	0	-	-
p	0.02	-	-
TR	13.5	-	-
Initiate Fault Location	Disabled		
ProLogic Control	Disabled		
50N/51N/67 - Neutral Overcurrent			
50N/67	Disabled		
Directional Control	forward		
Pickup	5	amperes	0.25 to 50.00
Pickup Delay	1	seconds	0.01 to 99.99
51N/67	Disabled		
Directional Control	forward		
Pickup	1	amperes	0.25 to 50.00
Curve Type	IEC standard inverse		
TMS	1	-	0.01 to 10.00
A	0.14	-	-
B	0	-	-
p	0.02	-	-
TR	13.5	-	-
Initiate Fault Location	Disabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
ProLogic Control	Disabled		
50G/51G/67- Measured Neutral Over-current			
50G-1/67	Disabled		
Directional Control	forward		
Pickup	1	amperes	0.25 to 50.00
Pickup Delay	1	seconds	0.01 to 99.99
50G-2/67	Disabled		
Directional Control	forward		
Pickup	1	amperes	0.25 to 50.00
Pickup Delay	1	seconds	0.01 to 99.99
51G/67	Disabled		
Directional Control	forward		
Pickup	1	amperes	0.25 to 50.00
Curve Type	IEC standard inverse		
TMS	1	-	0.01 to 10.00
A	0.14	-	-
B	0	-	-
p	0.02	-	-
TR	13.5	-	-
Initiate Fault Location	Disabled		
ProLogic Control	Disabled		
46-50/46-51/67 - Negative Sequence Overcurrent			
46-50/67	Disabled		
Directional Control	forward		
Pickup	2.5	amperes	0.25 to 50.00
Pickup Delay	1	seconds	0.01 to 99.99
46-51/67	Disabled		
Directional Control	forward		
Pickup	1	amperes	0.25 to 50.00
Curve Type	IEC standard inverse		
TMS	1	-	0.01 to 10.00
A	0.14	-	-
B	0	-	-
p	0.02	-	-
TR	13.5	-	-
Initiate Fault Location	Disabled		
ProLogic Control	Disabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
25/27/59 - Sync Check			
25 Sync Check	Disabled		
Maximum Voltage	70	volts	60.0 to 138.0
Minimum Voltage	60	volts	40.0 to 69.9
Angle Difference	20	degrees	1.0 to 50.0
Pickup Delay	0.02	seconds	0.00 to 99.99
Dead Main Live Sync (DMLS)	Disabled		
Live Main Dead Sync (LMDS)	Disabled		
Dead Main Dead Sync (DMDS)	Disabled		
79 - Recloser			
Main	Disabled		
Number of Shots	4		
First Reclose (T1)	1	seconds	0.02 to 999.99
Second Reclose (T2)	5	seconds	1.00 to 999.99
Third Reclose (T3)	10	seconds	1.00 to 999.99
Fourth Reclose (T4)	20	seconds	1.00 to 999.99
Close Time (Tp)	0.2	seconds	0.01 to 1.00
Lockout Reset (Td)	25	seconds	0.00 to 999.99
Initiate Reset (TDI)	1	seconds	0.00 to 999.99
Block Reset (TDB)	0.5	seconds	0.00 to 999.99
Sync Control	Disabled		
Aux	Disabled		
Number of Shots	4		
First Reclose (T1)	1	seconds	0.02 to 999.99
Second Reclose (T2)	5	seconds	1.00 to 999.99
Third Reclose (T3)	10	seconds	1.00 to 999.99
Fourth Reclose (T4)	20	seconds	1.00 to 999.99
Close Time (Tp)	0.2	seconds	0.01 to 1.00
Lockout Reset (Td)	25	seconds	0.00 to 999.99
Initiate Reset (TDI)	1	seconds	0.00 to 999.99
Block Reset (TDB)	0.5	seconds	0.00 to 999.99
Sync Control	Disabled		
59 - Overvoltage			
59-1	Disabled		
Gate Switch	OR		
Pickup	70	volts	1.0 to 138.0
Pickup Delay	1	seconds	0.00 to 99.99

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
59-2	Disabled		
Gate Switch	OR		
Pickup	70	volts	1.0 to 138.0
Pickup Delay	1	seconds	0.00 to 99.99
27 - Undervoltage			
27-1	Disabled		
Gate Switch	OR		
Pickup	20	volts	1.0 to 120.0
Pickup Delay	1	seconds	0.00 to 99.99
27-2	Disabled		
Gate Switch	OR		
Pickup	20	volts	1.0 to 120.0
Pickup Delay	1	seconds	0.00 to 99.99
60 - Loss of Potential Alarm			
60	Disabled		
81 - Over/Under Frequency			
81-1	Disabled		
Pickup	60.005	Hz	[50.000, 59.995] or [60.005, 70.000]
Pickup Delay	2	seconds	0.05 to 99.99
81-2	Disabled		
Pickup	60.005	Hz	[50.000, 59.995] or [60.005, 70.000]
Pickup Delay	2	seconds	0.05 to 99.99
81-3	Disabled		
Pickup	59.995	Hz	[50.000, 59.995] or [60.005, 70.000]
Pickup Delay	2	seconds	0.05 to 99.99
81-4	Disabled		
Pickup	59.995	Hz	[50.000, 59.995] or [60.005, 70.000]
Pickup Delay	2	seconds	0.05 to 99.99
32 - Directional Power			
32P	Disabled		
Pickup	3	amperes	[-15.00, -0.25] or [0.25, 15.00]
Pickup Delay	2	seconds	0.00 to 99.99
32Q	Disabled		
Pickup	3	amperes	[-15.00, -0.25] or [0.25, 15.00]
Pickup Delay	2	seconds	0.00 to 99.99
21P - Phase Distance			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
21P-1	Disabled		
Forward Reach	10	ohms	0.05 to 66.00
Delta Current Supervision	1	amperes	0.20 to 50.00
21P-2	Disabled		
Forward Reach	10	ohms	0.05 to 66.00
Delta Current Supervision	1	amperes	0.20 to 50.00
THD - Total Harmonic Distortion			
THD	Disabled		
Pickup	10	%	5.0 to 100.0
Demand Metering			
Demand Metering	Disabled		
Demand Interval	5	minutes	5 to 60
Demand Meter Type	Integrating		
I*I*t			
I*I*t Main	Disabled		
External Input or ProLogic for Trip	<disabled>		
I*I*t Limit	99999	(kA)^2*s	0.1 to 99999.0
I*I*t Aux	Disabled		
External Input or ProLogic for Trip	<disabled>		
I*I*t Limit	99999	(kA)^2*s	0.1 to 99999.0
PL 1 [ProLogic 1]			
ProLogic 1	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 2 [ProLogic 2]			
ProLogic 2	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 3 [ProLogic 3]			
ProLogic 3	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 4 [ProLogic 4]			
ProLogic 4	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 5			
Input E	<Unused = 0>		
PL 5 [ProLogic 5]			
ProLogic 5	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 6 [ProLogic 6]			
ProLogic 6	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 7 [ProLogic 7]			
ProLogic 7	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 8 [ProLogic 8]			
ProLogic 8	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 9 [ProLogic 9]			
ProLogic 9	Disabled		
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 10 [ProLogic 10]			
ProLogic 10	Disabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Pickup Delay	0	seconds	0.00 to 999.00
Dropout Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 1 [BkrLogic 1]			
BkrLogic 1	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 2 [BkrLogic 2]			
BkrLogic 2	Disabled		
Message Parameter	<none>		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 3 [BkrLogic 3]			
BkrLogic 3	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 4 [BkrLogic 4]			
BkrLogic 4	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 5 [BkrLogic 5]			
BkrLogic 5	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 6 [BkrLogic 6]			
BkrLogic 6	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 7 [BkrLogic 7]			
BkrLogic 7	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 8 [BkrLogic 8]			
BkrLogic 8	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 9 [BkrLogic 9]			
BkrLogic 9	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Breaker Logic 10 [BkrLogic 10]			
BkrLogic 10	Disabled		
Message Parameter	<none>		
Count Limit	0	-	0 to 99999
Pickup Delay (T1)	0	seconds	0.00 to 999.00
Drop Out Delay (T1)	0	seconds	0.00 to 999.00
Pickup Delay (T2)	0	seconds	0.00 to 999.00
Drop Out Delay (T2)	0	seconds	0.00 to 999.00
Pickup Delay (T3)	0	seconds	0.00 to 999.00
Drop Out Delay (T3)	0	seconds	0.00 to 999.00
Pickup Delay (T4)	0	seconds	0.00 to 999.00
Drop Out Delay (T4)	0	seconds	0.00 to 999.00

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 1 [Group Logic 1]			
Group Logic 1	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 2 [Group Logic 2]			
Group Logic 2	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Input E	<Unused = 0>		
Group Logic 3 [Group Logic 3]			
Group Logic 3	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 4 [Group Logic 4]			
Group Logic 4	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 5 [Group Logic 5]			
Group Logic 5	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 6 [Group Logic 6]			
Group Logic 6	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 7 [Group Logic 7]			
Group Logic 7	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 8 [Group Logic 8]			
Group Logic 8	Disabled		
Setting Group to Activate	<none>		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 9 [Group Logic 9]			
Group Logic 9	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 10 [Group Logic 10]			
Group Logic 10	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 5			
Input E	<Unused = 0>		
Group Logic 11 [Group Logic 11]			
Group Logic 11	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 12 [Group Logic 12]			
Group Logic 12	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 13 [Group Logic 13]			
Group Logic 13	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 14 [Group Logic 14]			
Group Logic 14	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 15 [Group Logic 15]			
Group Logic 15	Disabled		
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 16 [Group Logic 16]			
Group Logic 16	Disabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Setting Group to Activate	<none>		
Pickup Delay	0	seconds	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		

Appendix C Hardware Description

The relay is a complete Distribution Protection & Management relay package designed and manufactured with high quality features and recording components. The following information describes the main hardware components of the relay:

Main Processor Board (MPB)

The MPB has two processor sub-systems which control the operation of the entire relay: the DSP processor and the control processor. The DSP sub-system interfaces to the RAIB, the DIB and the OCB and manages the protection features of the relay. The control processor manages the user interface and system control features of the relay. Both subsystems operate independently of each other and will continue to function even if the other sub-system fails.

The MPB provides the following functionality:

- DSP processor subsystem which interfaces to the RAIB, the DIB and the OCB and manages the protection features of the relay, with:
  - The floating point DSP to provide fast capture and manipulation of data.
  - RAM and re-programmable non-volatile Flash memory. Allows operation independent of the control processor and supports field software updates.
- A control processor subsystem which manages the user interface and system control features of the relay, with
  - RAM and re-programmable non-volatile Flash memory. Allows operation independent of the DSP processor and supports field software upgrades.
  - Settings and recordings stored in non-volatile memory.
  - Runs a Real Time Operating System (RTOS).
  - Provides Ethernet ports and RS-232 ports for modem, SCADA, COM and USB interfaces.
- A time synchronism processor with automatic detection of modulated and unmodulated IRIG-B
- A high speed link is provided between the DSP and control processor subsystems.
- Sophisticated fault detection and “watchdog” recovery hardware
- The MPB also provides the power supply for the entire unit. The power supply operating range is 43 – 275 Vdc, 90 – 265 Vac 50/60 Hz. This wide operating range provides easier installation by eliminating power supply ordering options

Digital Input Board (DIB)

This board provides 9 digital input channels. Inputs are optically isolated, externally wetted, and factory preset to the customer’s requested voltage level of 48, 110/125 or 220/250 Vdc. This board interfaces to the MPB.

Rear Panel Comm Board (RPCB)

The RPCB provides the relay with two RS-232 ports (Ports 122 and 123, DB9F), IRIG-B time synchronization input (Port 121, male BNC), internal modem connection (Port 118, RJ-11) and two Ethernet ports (Ports 119 and 120, RJ-45 or 100BASE-FX MM 1300nm ST, depending upon order specification). The RPCB interfaces to the MPB. Port 119 is the exception in that it interfaces to the GFPCB where it shares an internal switch with the front panel LAN port. The switch then interfaces to the MPB.

Output Contact Board (FOCB)

The FOCB provides 14 normally open contact outputs for relaying, alarms and control. It also provides one normally closed output contact for relay inoperative indication. This board interfaces to the MPB.

Relay AC Analog Sensor Boards (RASB)

Each relay has 2 RASBs. One RASB have 6 current transformer inputs while the second have 4 voltage transformer inputs and one current transformer input. These boards provide 7 currents and 4 voltage AC analog measurement inputs. The RASB interface to the RAIB.

Relay AC Analog Input Board (RAIB)

The RAIB provides the analog to digital conversion of the 7 ac analog current inputs and the 4 ac analog voltage inputs. The sample rate is fixed at 96 samples/cycle. Each channel is simultaneously sampled using 16-bit analog to digital converters. The digitized data is sent to the MPB for processing and implementation of the protection algorithms.

- A time synchronism processor with automatic detection of modulated and unmodulated IRIG-B
- A high speed link is provided between the DSP and control processor subsystems.
- Sophisticated fault detection and “watchdog” recovery hardware
- The MPB also provides the power supply for the entire unit. The power supply operating range is 43 – 275 Vdc, 90 – 265 Vac 50/60 Hz. This wide operating range provides easier installation by eliminating power supply ordering options

Graphics Front Panel Comm Board (GFPCB)

The GFPCB provides the front panel USB and Ethernet ports, the front panel status LEDs and interfaces the MPB to the FPDB. The MPB controls the state of the LEDs.

Graphics Front Panel Display Board (GFPDB)

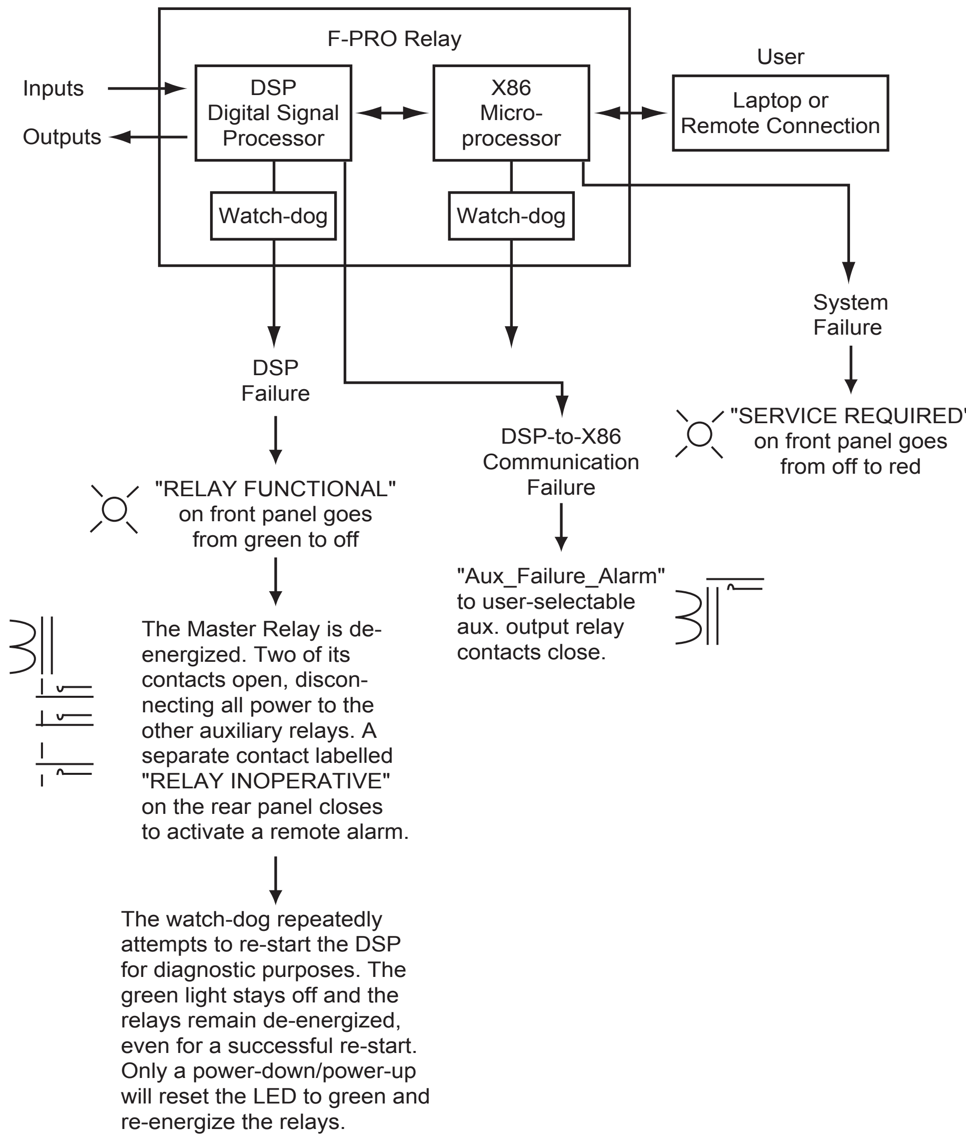
The GFPDB provides the 240x128 monochrome graphics front panel display and the keypad. The keypad is used to navigate the menus on the display to control relay operation by a local user.

Appendix D Event Messages

F-PRO Event Messages	
Event Log Message	**Notes**
50LS-1 Main ABC:Trip	The possible phase information will be: • A • B • C • AB • BC • CA • ABC
50LS-2 Main ABC:Trip	
50LS-1 Aux ABC:Trip	
50LS-2 Aux ABC:Trip	
50BF-1 Main ABC:Trip	
50BF-2 Main ABC:Trip	
50BF-1 Aux ABC:Trip	
50BF-2 Aux ABC:Trip	
51/67 ABC 1234.5km:Alarm	Fault Location will be included if enabled The possible phase information will be: • A • B • C • AB • BC • CA • ABC
50/67 ABC 1234.5km:Trip	
51/67 ABC 1234.5km:Trip	
51N/67 1234.5km:Alarm	Fault Location will be included if enabled
50N/67 1234.5km:Trip	
51N/67 1234.5km:Trip	
46-51/67 1234.5km:Alarm	
46-50/67 1234.5km:Trip	
46-51/67 1234.5km:Trip	
51G/67 1234.5km:Alarm	
50G-1/67 1234.5km:Trip	
50G-2/67 1234.5km:Trip	
51G/67 1234.5km:Trip	
25/27/59 Sync Check: High	
79 Initiated: High	Recloser is initiated.
79 Main Lockout: High	Recloser shot count has expired and reclosing attempts are blocked.
79 Aux Lockout: High	Recloser shot count has expired and reclosing attempts are blocked.
79 Main Reclose: shot n	Recloser Main circuit breaker close attempt where n equals the shot count.
79 Aux Reclose: shot n	Recloser Aux. circuit breaker close attempt where n equals the shot count.
79 Block: High	Recloser is blocked by an external signal.

F-PRO Event Messages	
59-1 ABC:Trip	The possible phase information will be: • A • B • C • AB • BC • CA • ABC
59-2 ABC:Trip	
27-1 ABC:Trip	
27-2 ABC:Trip	
60 LOP ABC:Alarm	
32P ABC:Trip	
32Q ABC:Trip	
81-1: Trip	
81-2: Trip	
81-3: Trip	
81-4: Trip	
THD Alarm:High	
ProLogic Name: PL*n*	ProLogic outputs names are user-assigned Where n = 1-10
Extern Input Name: EI*n*	External input names are user-assigned Where n = 1-9
BkrLogic Name *msgParam*:BLn	Breaker Logic outputs names are user-assigned Where msgParam = none, timers 1 to 4, or count limit Where n = 1-10
BkrLogic Name Upper Limit Reset:(*msg-Param*)BLn	Breaker Logic outputs names are user-assigned Where msgParam = count limit Where n = 1-10
BkrLogic Name Input Reset:(*msgParam*-BLn	
I*I*t Main Limit:99999.0	
I*I*t Aux Limit:99999.0	
MWh IN Count Rollover Reset:9800	
MWh OUT Count Rollover Reset:9800	
MVARh IN Count Rollover Reset:9800	
MVARh OUT Count Rollover Reset:9800	
New Settings loaded, Active group n.	Where n = 1-8
Manual Settings Load request, activate SGn	Manual or user-initiated settings change.
Manual Settings Load request completed	Completion of user-initiated settings change.
Changed Active Group from x to y Logic n	This happens when relay changes setting group. Automatic group logic initiated setting group change
User changed Active Group from x to y	This happens when the relay changes setting group. User-initiated setting group change
Unit Recalibrated	
Unit restarted	
User logged In	

Details of Failure Modes



> Note: For either of the above cases the DSP controller functions continue with normal auxiliary relay outputs, provided that DSP failure has not occurred.

Appendix E Modbus RTU Communication Protocol

The SCADA port supports DNP3 and Modicon Modbus protocols. All metering values available through the terminal user interface are also available via the Modbus protocol. Additionally, the Modbus protocol support the reading of the unit time and time of the readings and provides access to trip and alarm events, include fault location information.

A “Hold Readings” function is available to freeze all metering readings into a snapshot (see Force Single Coil function, address 0).

Read Coil Status (Function Code 01)			
Channel	**Address**	**Value**	
Hold Readings	1	0: Readings not held	1: Readings held
Reserved	257	Reserved	Reserved
Output Contact 1	513	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 2	514	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 3	515	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 4	516	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 5	517	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 6	518	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 7	519	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 8	520	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 9	521	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 10	522	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 11	523	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 12	524	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 13	525	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 14	526	0: Contact Open (inactive)	1: Contact Closed (active)
50LS-1 Main Trip	769	0: Off (inactive)	1: On (active)
50LS-2 Main Trip	770	0: Off (inactive)	1: On (active)
50LS-1 Aux Trip	771	0: Off (inactive)	1: On (active)
50LS-2 Aux Trip	772	0: Off (inactive)	1: On (active)
50BF-1 Main Trip	773	0: Off (inactive)	1: On (active)
50BF-2 Main Trip	774	0: Off (inactive)	1: On (active)
50BF-1 Aux Trip	775	0: Off (inactive)	1: On (active)
50BF-2 Aux Trip	776	0: Off (inactive)	1: On (active)
25/27/59 Sync Check	777	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
Channel	**Address**	**Value**	
79 Main Reclose	778	0: Off (inactive)	1: On (active)
79 Aux Reclose	779	0: Off (inactive)	1: On (active)
50/67 Trip	780	0: Off (inactive)	1: On (active)
51/67 Trip	781	0: Off (inactive)	1: On (active)
51/67 Trip	782	0: Off (inactive)	1: On (active)
50N/67 Trip	783	0: Off (inactive)	1: On (active)
51N/67 Trip	784	0: Off (inactive)	1: On (active)
51N/67 Alarm	785	0: Off (inactive)	1: On (active)
46-50/67 Trip	786	0: Off (inactive)	1: On (active)
46-51/67 Trip	787	0: Off (inactive)	1: On (active)
46-51/67 Alarm	788	0: Off (inactive)	1: On (active)
32P Trip	789	0: Off (inactive)	1: On (active)
32Q Trip	790	0: Off (inactive)	1: On (active)
59-1 Trip	791	0: Off (inactive)	1: On (active)
59-2 Trip	792	0: Off (inactive)	1: On (active)
27-1 Trip	793	0: Off (inactive)	1: On (active)
27-2 Trip	794	0: Off (inactive)	1: On (active)
50G1/67	795	0: Off (inactive)	1: On (active)
50G2/67	796	0: Off (inactive)	1: On (active)
51G/67 ALARM	797	0: Off (inactive)	1: On (active)
51G/67 TRIP	798	0: Off (inactive)	1: On (active)
60 Alarm	799	0: Off (inactive)	1: On (active)
81-1 Trip	800	0: Off (inactive)	1: On (active)
81-2 Trip	801	0: Off (inactive)	1: On (active)
81-3 Trip	802	0: Off (inactive)	1: On (active)
81-4 Trip	803	0: Off (inactive)	1: On (active)
THD Alarm	804	0: Off (inactive)	1: On (active)
Auxillary Alarm	805	0: Off (inactive)	1: On (active)
ProLogic 1	806	0: Off (inactive)	1: On (active)
ProLogic 2	807	0: Off (inactive)	1: On (active)
ProLogic 3	808	0: Off (inactive)	1: On (active)
ProLogic 4	809	0: Off (inactive)	1: On (active)
ProLogic 5	810	0: Off (inactive)	1: On (active)
ProLogic 6	811	0: Off (inactive)	1: On (active)
ProLogic 7	812	0: Off (inactive)	1: On (active)
ProLogic 8	813	0: Off (inactive)	1: On (active)
ProLogic 9	814	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
Channel	**Address**	**Value**	
ProLogic 10	815	0: Off (inactive)	1: On (active)
Breaker Logic 1	816	0: Off (inactive)	1: On (active)
Breaker Logic 2	817	0: Off (inactive)	1: On (active)
Breaker Logic 3	818	0: Off (inactive)	1: On (active)
Breaker Logic 4	819	0: Off (inactive)	1: On (active)
Breaker Logic 5	820	0: Off (inactive)	1: On (active)
Breaker Logic 6	821	0: Off (inactive)	1: On (active)
Breaker Logic 7	822	0: Off (inactive)	1: On (active)
Breaker Logic 8	823	0: Off (inactive)	1: On (active)
Breaker Logic 9	824	0: Off (inactive)	1: On (active)
Breaker Logic 10	825	0: Off (inactive)	1: On (active)
79 Initialize	826	0: Off (inactive)	1: On (active)
79 Block	827	0: Off (inactive)	1: On (active)
79 Main Lockout	828	0: Off (inactive)	1: On (active)
79 Aux Lockout	829	0: Off (inactive)	1: On (active)
50BF Initiate	830	0: Off (inactive)	1: On (active)
Group Logic 1	831	0: Off (inactive)	1: On (active)
Group Logic 2	821	0: Off (inactive)	1: On (active)
Group Logic 3	833	0: Off (inactive)	1: On (active)
Group Logic 4	834	0: Off (inactive)	1: On (active)
Group Logic 5	835	0: Off (inactive)	1: On (active)
Group Logic 6	836	0: Off (inactive)	1: On (active)
Group Logic 7	837	0: Off (inactive)	1: On (active)
Group Logic 8	838	0: Off (inactive)	1: On (active)
Group Logic 9	839	0: Off (inactive)	1: On (active)
Group Logic 10	840	0: Off (inactive)	1: On (active)
Group Logic 11	841	0: Off (inactive)	1: On (active)
Group Logic 12	842	0: Off (inactive)	1: On (active)
Group Logic 13	843	0: Off (inactive)	1: On (active)
Group Logic 14	844	0: Off (inactive)	1: On (active)
Group Logic 15	845	0: Off (inactive)	1: On (active)
Group Logic 16	846	0: Off (inactive)	1: On (active)

Read Input Status (Function Code 02)			
Channel	**Address**	**Value**	
External Input 1	10001	0: Off (inactive)	1: On (active)

Read Input Status (Function Code 02)			
External Input 2	10002	0: Off (inactive)	1: On (active)
External Input 3	10003	0: Off (inactive)	1: On (active)
External Input 4	10004	0: Off (inactive)	1: On (active)
External Input 5	10005	0: Off (inactive)	1: On (active)
External Input 6	10006	0: Off (inactive)	1: On (active)
External Input 7	10007	0: Off (inactive)	1: On (active)
External Input 8	10008	0: Off (inactive)	1: On (active)
External Input 9	10009	0: Off (inactive)	1: On (active)
External Input 1 Change of state latch	10257	0: Off (inactive)	1: On (active)
External Input 2 Change of state latch	10258	0: Off (inactive)	1: On (active)
External Input 3 Change of state latch	10259	0: Off (inactive)	1: On (active)
External Input 4 Change of state latch	10260	0: Off (inactive)	1: On (active)
External Input 5 Change of state latch	10261	0: Off (inactive)	1: On (active)
External Input 6 Change of state latch	10262	0: Off (inactive)	1: On (active)
External Input 7 Change of state latch	10263	0: Off (inactive)	1: On (active)
External Input 8 Change of state latch	10264	0: Off (inactive)	1: On (active)
External Input 9 Change of state latch	10265	0: Off (inactive)	1: On (active)
Virtual Input 1	10513	0: Off (inactive)	1: On (active)
Virtual Input 2	10514	0: Off (inactive)	1: On (active)
Virtual Input 3	10515	0: Off (inactive)	1: On (active)
Virtual Input 4	10516	0: Off (inactive)	1: On (active)
Virtual Input 5	10517	0: Off (inactive)	1: On (active)
Virtual Input 6	10518	0: Off (inactive)	1: On (active)
Virtual Input 7	10519	0: Off (inactive)	1: On (active)
Virtual Input 8	10520	0: Off (inactive)	1: On (active)
Virtual Input 9	10521	0: Off (inactive)	1: On (active)
Virtual Input 10	10522	0: Off (inactive)	1: On (active)
Virtual Input 11	10523	0: Off (inactive)	1: On (active)
Virtual Input 12	10524	0: Off (inactive)	1: On (active)
Virtual Input 13	10525	0: Off (inactive)	1: On (active)
Virtual Input 14	10526	0: Off (inactive)	1: On (active)
Virtual Input 15	10527	0: Off (inactive)	1: On (active)
Virtual Input 16	10528	0: Off (inactive)	1: On (active)
Virtual Input 17	10529	0: Off (inactive)	1: On (active)
Virtual Input 18	10530	0: Off (inactive)	1: On (active)
Virtual Input 19	10531	0: Off (inactive)	1: On (active)
Virtual Input 20	10532	0: Off (inactive)	1: On (active)
Virtual Input 21	10533	0: Off (inactive)	1: On (active)
Virtual Input 22	10534	0: Off (inactive)	1: On (active)
Virtual Input 23	10535	0: Off (inactive)	1: On (active)
Virtual Input 24	10536	0: Off (inactive)	1: On (active)
Virtual Input 25	10537	0: Off (inactive)	1: On (active)
Virtual Input 26	10538	0: Off (inactive)	1: On (active)
Virtual Input 27	10539	0: Off (inactive)	1: On (active)
Virtual Input 28	10540	0: Off (inactive)	1: On (active)
Virtual Input 29	10541	0: Off (inactive)	1: On (active)
Virtual Input 30	10542	0: Off (inactive)	1: On (active)

Read Holding Registers (Function Code 03)			
Channel		**Units**	**Scale**
F-PRO Clock Time (UTC). Read all in same query to ensure consistent time reading data			
Milliseconds Now * Millisecond information not supported.	40001	0	1
Seconds Now	40002	0-59	1
Minutes Now	40003	0-59	1
Hours Now	40004	0-23	1
Day of Year Now	40005	1-365 (up to 366 if leap year)	1
Years since 1900	40006	90-137	1
Sync'd to IRIG-B	40007	0: No 1: Yes	1
Time of Acquisition (UTC). Read all in same query to ensure consistent time reading data			
Milliseconds Now * Millisecond information not supported.	40008	0	1
Seconds Now	40009	0-59	1
Minutes Now	40010	0-59	1
Hours Now	40011	0-23	1
Day of Year Now	40012	1-365 (up to 366 if leap year)	1
Years since 1900	40013	90-137	1
Sync'd to IRIG-B	40014	0: No 1: Yes	1
Milliseconds Now	40015	2's complement half hours, North America is negative	1

Channel	Address	Units	Scale
Main Va Magnitude	40257	kV	10
Main Va Angle	40258	degrees	10
Main Vb Magnitude	40259	kV	10
Main Vb Angle	40260	degrees	10
Main Vc Magnitude	40261	kV	10
Main Vc Angle	40262	degrees	10
Main Ia Magnitude	40263	A	1
Main Ia Angle	40264	degrees	10
Main Ib Magnitude	40265	A	1
Main Ib Angle	40266	degrees	10
Main Ic Magnitude	40267	A	1

Channel	Address	Units	Scale
Main Ic Angle	40268	degrees	10
Aux Ia Magnitude	40269	A	1
Aux Ia Angle	40270	degrees	10
Aux Ib Magnitude	40271	A	1
Aux Ib Angle	40272	degrees	10
Aux Ic Magnitude	40273	A	1
Aux Ic Angle	40274	degrees	10
Line Ia Magnitude	40275	A	1
Line Ia Angle	40276	degrees	10
Line Ib Magnitude	40277	A	1
Line Ib Angle	40278	degrees	10
Line Ic Magnitude	40279	A	1
Line Ic Angle	40280	degrees	10
Sync V Magnitude	40281	kV	10
Sync V Angle	40282	degrees	10
Real Power (P)	40283	MW	10
Reactive Power (Q)	40284	MVAR	10
Pos Seq Voltage	40285	kV	10
Pos Seq Current	40286	A	1
Frequency	40287	Hz	100
THD	40288	%	100
Active Setting Group Numbers	40289		
Demand Real Power Out	40290	MW	10
Demand Real Power In	40291	MW	10
Demand Reactive Power In	40292	MVAR	10
Demand Reactive Power Out	40293	MVAR	10
Demand A-Phase Voltage	40294	kV	10
Demand B-Phase Voltage	40295	kV	10
Demand C-Phase Voltage	40296	kV	10
Demand A-Phase Current	40297	A	1
Demand B-Phase Current	40298	A	1
Demand A-Phase Current	40299	A	1
Demand System Frequency	40300	Hz	300
Demand Maximum THD along all current	40301	%	100
3-phase MWh Out	40302	MWh	0.333
3-phase MWh In	40303	MWh	0.333
3-phase MVARh Out	40304	MVARh	0.333
3-phase MVARh In	40305	MVARh	0.333

Channel	Address	Units	Scale
BkrLogic 1 Count	40306		1
BkrLogic 2 Count	40307		1
BkrLogic 3 Count	40308		1
BkrLogic 4 Count	40309		1
BkrLogic 5 Count	40310		1
BkrLogic 6 Count	40311		1
BkrLogic 7 Count	40312		1
BkrLogic 8 Count	40313		1
BkrLogic 9 Count	40314		1
BkrLogic 10 Count	40315		1
I^2t Main Accumulated	40316		1
I^2t Main for last operation	40317		10
I^2t Aux Accumulated	40318		1
I^2t Aux or last operation	40319		10
3Io Magnitude	40320	A	1
3Io Angle	40321	deg	10
Ig Magnitude	40322	A	1
Ig Angle	40323	deg	10

Read Input Register (Function Code 04)
No input registers supported. Response fron IED indicates "ILLEGAL FUNCTION."

Force Single Coil (Function Code 05)			
Only the "hold readings" coil can be forced. When active, this coil locks all coil, input and holding register readings simultaneously at their present values. When inactive, coil, input and holding register values will read their most recently available state.			
Channel	**Type**	**Address**	**Value**
Hold Readings	Read/Write	01	0000: Readings update normally (inactive) FF00: Hold readings (active)
Energy Reset		257	
Reset Breaker Logic 1		258	
Reset Breaker Logic 2		259	
Reset Breaker Logic 3		260	
Reset Breaker Logic 4		261	
Reset Breaker Logic 5		262	
Reset Breaker Logic 6		263	
Reset Breaker Logic 7		264	
Reset Breaker Logic 8		265	
Reset Breaker Logic 9		266	
Reset Breaker Logic 10		267	
I^2t Main Reset		268	
I^2t Aux Reset		269	
Demand Reset		270	

Preset Single Register (Function Code 06)			
Channel	**Address**	**Value**	**Scaled Up By**
Event Message Control (See below for details of use)			
Refresh event list	40513	No data required	N/A
Acknowledge the current event and get the next event	40514	No data required	N/A
Get the next event (without acknowledge)	40515	No data required	N/A

Diagnostic Subfunctions (Function Code 08)	
Return Query Data (Subfunction 00)	This provides an echo of the submitted message.
Restart Comm. Option (Subfunction 01)	This restarts the Modbus communications process.
Force Listen Only Mode (Subfunction 04)	No response is returned. IED enters “Listen Only” mode. This mode can only be exited by the “Restart Comm. Option” command.

Report Slave ID (Function Code 17/0x11)			
A fixed response is returned by the IED, including system model, version and issue numbers.			
Channel	**Type**	**Bytes**	**Value**
Model Number	Read Only	0 and 1	0 x 13EC = 5100 decimal
Version Number	Read Only	2 and 3	Version number
Issue Number	Read Only	4 and 5	Issue number

- The F-PRO IED model number is 4000.
- Version and issue will each be positive integers, say X and Y.
- The F-PRO is defined as “Model 4000, Version X Issue B”

Accessing F-PRO Event Information	
All F-PRO detector event messages displayed in the Event Log are available via Modbus. This includes fault location information. The following controls are available.	
Refresh Event List	(Function Code 6, address 40513): Fetches the latest events from the F-PRO's event log and makes them available for Modbus access. The most recent event becomes the current event available for reading.
Acknowledge Current Event and Get Next Event	(Function Code 6, address 40514): Clears the current event from the read registers and places the next event into them. An acknowledged event is no longer available for reading.
Get Next Event	(Function Code 6, address 40515): Places the next event in the read registers without acknowledging the current event. The current event will reappear in the list when Refresh Event List is used.
Size of Current Event Message	(Function Code 3, address 40516): Indicates the number of 16 bit registers used to contain the current event. Event data is stored with two characters per register. A reading of zero indicates that there are no unacknowledged events available in the current set. (NB. The Refresh Event List function can be used to check for new events that have occurred since the last Refresh Event List.)
	(Function Code 3, address 40517): Identifies fault location events. These events are identified by “FL” in this register. Non-fault location events contain “ ” in this location.
Read Event Message	(Function Code 3, addresses 40518 - 40576): Contains the current event message. Two ASCII characters are packed into each 16 bit register. All unused registers in the set are set to 0.

Register	Value	Meaning	
	High Byte	Low Byte	
40516	0x00	0x1B	Event text size = 27 (0x1B hex)
40517	0x46	0x4C	‘FL’ - Fault locator event
40518	0x32	0x30	‘2’, ‘0’
40519	0x30	0x30	‘0’, ‘0’
40520	0x53	0x65	‘S’, ‘e’
40521	0x70	0x32	‘p’, ‘2’
40522	0x31	0x20	‘1’, ‘ ’
40523	0x32	0x30	‘2’, ‘0’
40524	0x3A	0x31	‘:’, ‘1’
40525	0x36	0x3A	‘6’, ‘:’
40526	0x31	0x36	‘1’, ‘6’
40527	0x2E	0x39	‘.’, ‘9’
40528	0x36	0x36	‘6’, ‘6’
40529	0x20	0x3A	‘ ’, ‘:’
40530	0x20	0x35	‘ ’, ‘5’
40531	0x30	0x2D	‘ 0’, ‘-’
40532	0x31	0x20	‘1’, ‘ ‘
40533	0x54	0x72	‘T’, ‘r’
40534	0x69	0x70	‘i’, ‘p’
40535	0x20	0x41	‘ ’, ‘A’
40536	0x42	0x20	‘B’, ‘ ‘
40537	0x31	0x2E	‘1’, ‘.’
40538	0x30	0x6B	‘0 ’, ‘k’
40539	0x6D	0x0	‘m’, ‘ ’

Appendix F DNP3 Device Profile

Device Properties

This document shows the device capabilities and the current value of each parameter for the default unit configuration as defined in the default configuration file.

1.1 Device Identification	Capabilities	Current Value	If configurable, list methods
1.1.1 Device Function:	○ Master ● Outstation	○ Master ● Outstation	
1.1.2 Vendor Name:		ERLPhase Power Technologies	
1.1.3 Device Name:		F-PRO 4000	
1.1.4 Device manufacturer's hardware version string:		NA	
1.1.5 Device manufacturer's software version string:		NA	
1.1.6 Device Profile Document Version Number:		V01.0, Sept. 26, 2013	
1.1.7 DNP Levels Supported for:	Outstations Only Requests and Responses ☐ None ☐ Level 1 ☒ Level 2 ☐ Level 3		
1.1.8 Supported Function Blocks:	☐ Self-Address Reservation ☐ Object 0 - attribute objects ☐ Data Sets ☐ File Transfer ☐ Virtual Terminal ☐ Mapping to IEC 61850 Object Models defined in a DNP3 XML file		
1.1.9 Notable Additions:	• Start-stop (qualifier codes 0x00 and 0x01), limited quantity (qualifier codes 0x07 and 0x08) and indices (qualifier codes 0x17 and 0x28) for Binary Inputs, Binary Outputs and Analog Inputs (object groups 1, 10 and 30) • 32-bit and 16-bit Analog Inputs with and without flag (variations 1, 2, 3 and 4) • Analog Input events with time (variations 3 and 4) • Fault Location information as analog readings • Event Log messages as Object groups 110 and 111		

1.1 Device Identification	Capabilities	Current Value	If configurable, list methods
1.1.10 Methods to set Configurable Parameters:	☐ XML - Loaded via DNP3 File Transfer ☐ XML - Loaded via other transport mechanism ☐ Terminal - ASCII Terminal Command Line ☒ Software - Vendor software named F-PRO Offliner ☐ Proprietary file loaded via DNP3 file transfer ☐ Proprietary file loaded via other transport mechanism ☐ Direct - Keypad on device front panel ☐ Factory - Specified when device is ordered ☐ Protocol - Set via DNP3 (e.g. assign class) ☐ Other - explain _________________		
1.1.11 DNP3 XML files available On-Line:	RdWrFilenameDescription of Contents ☐ dnpDP.xml Complete Device Profile ☐ dnpDPcap.xml Device Profile Capabilities ☐ dnpDPcfg.xml Device Profile config. values ☐ ☐ _____*.xml ___________________ *The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns. *The Device Profile Capabilities contains only the capabilities and configurable methods columns. *The Device Profile Config. Values contains only the Current Value column.	Not supported	
1.1.12 External DNP3 XML files available Off-line:	Rd WrFilenameDescription of Contents ☐ ☐ dnpDP.xml Complete Device Profile ☐ ☐ dnpDPcap.xml Device Profile Capabilities ☐ ☐ dnpDPcfg.xml Device Profile config. values ☐ ☐ _______*.xml ___________________ *The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns. *The Device Profile Capabilities contains only the capabilities and configurable methods columns. *The Device Profile Config. Values contains only the Current Value column.	Not supported	
1.1.13 Connections Supported:	☒ Serial (complete section 1.2) ☒ IP Networking (complete section 1.3) ☐ Other, explain ______________________		

1.2 Serial Connections	**Capabilities**	**Current Value**	**If configurable, list methods**
1.2.1 Port Name	Port 122		
1.2.2 Serial Connection Parameters:	☐ Asynchronous - 8 Data Bits, 1 Start Bit, 1 Stop Bit, No Parity ☒ Other, explain - Asynchronous with selectable parity	Not configured for DNP	F-PRO Offliner
1.2.3 Baud Rate:	☐ Fixed at _______ ☐ Configurable, range _______ to _______ ☒ Configurable, selectable from 300, 1200, 2400, 9600, 19200, 38400 and 57600 ☐ Configurable, other, describe_______________	Not configured for DNP	F-PRO Offliner
1.2.4 Hardware Flow Control (Handshaking): Describe hardware signaling requirements of the interface. Where a transmitter or receiver is inhibited until a given control signal is asserted, it is considered to require that signal prior to sending or receiving characters. Where a signal is asserted prior to transmitting, that signal will be maintained active until after the end of transmission. Where a signal is asserted to enable reception, any data sent to the device when the signal is not active could be discarded.	☐ None **RS-232 / V.24 / V.28 Options:** Before Tx, Asserts: ☐ RTS ☐ DTR Before Rx, Asserts: ☐ RTS ☐ DTR Always Asserts: ☒ RTS ☒ DTR Before Tx, Requires: Asserted / Deasserted ☐ / ☐ CTS ☐ / ☐ DCD ☐ / ☐ DSR ☐ / ☐ RI ☐ / ☐ Rx Inactive Before Rx, Requires: Asserted / Deasserted ☐ / ☐ CTS ☐ / ☐ DCD ☐ / ☐ DSR ☐ / ☐ RI Always Ignores: ☒ CTS ☒ DCD ☒ DSR ☒ RI ☐ Other, explain ____________ **RS-422 / V.11 Options:** ☐ Requires Indication before Rx ☐ Asserts Control before Tx ☐ Other, explain ____________ **RS-485 Options:** ☐ Requires Rx inactive before Tx ☐ Other, explain ____________		
1.2.5 Interval to Request Link Status:	☒ Not Supported ☐ Fixed at_________ seconds ☐ Configurable, range _____ to ______ seconds ☐ Configurable, selectable from __,__,__ seconds ☐ Configurable, other, describe______________		
1.2.6 Supports DNP3 Collision Avoidance:	☒ No ☐ Yes, explain ______________________		

1.2 Serial Connections	Capabilities	Current Value	If configurable, list methods
1.2.7 Receiver Inter-character Timeout:	☒ Not checked ☐ No gap permitted ☐ Fixed at _____ bit times ☐ Fixed at _____ ms ☐ Configurable, range ____ to ____ bit times ☐ Configurable, range ____ to ____ ms ☐ Configurable, Selectable from __,__,__bit times ☐ Configurable, Selectable from ___, ___, ___ ms ☐ Configurable, other, describe______________ ☐ Variable, explain ____		
1.2.8 Inter-character gaps in transmission:	☒ None (always transmits with no inter-character gap) ☐ Maximum _____ bit times ☐ Maximum _____ ms		

1.3 IP Networking	Capabilities	Current Value	If configurable, list methods
1.3.1 Port Name	Port 119 and 120 Network		
1.3.2 Type of End Point:	☐ TCP Initiating (Master Only) ☒ TCP Listening (Outstation Only) ☐ TCP Dual (required for Masters) ☒ UDP Datagram (required)	Not configured for DNP	F-PRO Offliner
1.3.3 IP Address of this Device:		192.168.100.101	F-PRO Maintenance utilities
1.3.4 Subnet Mask:		Not set	F-PRO Maintenance utilities
1.3.5 Gateway IP Address:		Not set	F-PRO Maintenance utilities
1.3.6 Accepts TCP Connections or UDP Datagrams from:	☒ Allows all (show as *.*.*.* in 1.3.7) ☒ Limits based on an IP address ☒ Limits based on list of IP addresses ☐ Limits based on a wildcard IP address ☐ Limits based on list of wildcard IP addresses ☐ Other validation, explain_________________	Limits based on an IP address	F-PRO Offliner
1.3.7 IP Address(es) from which TCP Connections or UDP Datagrams are accepted:		192.168.1.1	F-PRO Offliner
1.3.8 TCP Listen Port Number:	☐ Not Applicable (Master w/o dual end point) ☐ Fixed at 20,000 ☒ Configurable, range 1025 to 32737 ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	20,000	F-PRO Offliner
1.3.9 TCP Listen Port Number of remote device:	☒ Not Applicable (Outstation w/o dual end point) ☐ Fixed at 20,000 ☐ Configurable, range _______ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	NA	
1.3.10 TCP Keep-alive timer:	☐ Fixed at ___________ms ☒ Configurable, range 5 to 3,600 s ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe______________	Disabled	F-PRO Offliner
1.3.11 Local UDP port:	☐ Fixed at 20,000 ☒ Configurable, range 1025 to 32737 ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ Let system choose (Master only)	20,000	F-PRO Offliner
1.3.12 Destination UDP port for initial unsolicited null responses (UDP only Outstations):	☒ None ☐ Fixed at 20,000 ☐ Configurable, range _______ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	NA	

1.3 IP Networking	Capabilities	Current Value	If configurable, list methods
1.3.13 Destination UDP port for responses:	☐ None ☐ Fixed at 20,000 ☒ Configurable, range 1025 to 32737 ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ Use source port number	20,000	F-PRO Offliner
1.3.14 Multiple master connections (Outstations Only):	☒ Supports multiple masters (Outstations only) If supported, the following methods may be used: ☒ Method 1 (based on IP address) - required ☒ Method 2 (based on IP port number) - recommended ☒ Method 3 (browsing for static data) - optional	Method 1 (based on IP address)	F-PRO Offliner
1.3.15 Time synchronization support:	☐ DNP3 LAN procedure (function code 24) ☐ DNP3 Write Time (not recommended over LAN) ☐ Other, explain ________________________ ☒ Not Supported		

1.4 Link Layer		Current Value	If configurable, list methods
1.4.1 Data Link Address:	☐ Fixed at______ ☒ Configurable, range 1 to 65519 ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	1	F-PRO Offliner
1.4.2 DNP3 Source Address Validation:	☒ Never ☐ Always, one address allowed (shown in 1.4.3) ☐ Always, any one of multiple addresses allowed ☐ (each selectable as shown in 1.4.3) ☐ Sometimes, explain________________		
1.4.3 DNP3 Source Address(es) expected when Validation is Enabled:	☐ Configurable to any 16 bit DNP Data Link Address value ☐ Configurable, range _______ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	NA	
1.4.4 Self Address Support using address 0xFFFC:	☐ Yes (only allowed if configurable) ☒ No	NA	
1.4.5 Sends Confirmed User Data Frames:	☐ Always ☐ Sometimes, explain _____________________ ☐ Never ☒ Configurable, either always or never		F-PRO Offliner (to disable, set Data Link Time-out to 0)
1.4.6 Data Link Layer Confirmation Timeout:	☐ None ☐ Fixed at __ ms ☒ Configurable, range 0 to 2,000 ms ☐ Configurable, selectable from____________ms ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	500	
1.4.7 Maximum Data Link Retries:	☐ Never Retries ☒ Fixed at 3 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	3	
1.4.8 Maximum number of octets Transmitted in a Data Link Frame:	☒ Fixed at 292 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	292	
1.4.9 Maximum number of octets that can be Received in a Data Link Frame:	☒ Fixed at 292 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	292	

1.5 Application Layer		**Current Value**	**If configurable, list methods**
1.5.1 Maximum number of octets Transmitted in an Application Layer Fragment other than File Transfer:	☒ Fixed at 2048 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	2048	
1.5.2 Maximum number of octets Transmitted in an Application Layer Fragment containing File Transfer:	☐ Fixed at ___________ ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	NA	
1.5.3 Maximum number of octets that can be Received in an Application Layer Fragment:	☒ Fixed at 2048 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	2048	
1.5.4 Timeout waiting for Complete Application Layer Fragment:	☐ None ☒ Fixed at 2,000 ms ☐ Configurable, range _______ to _______ms ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	2,000 ms	
1.5.5 Maximum number of objects allowed in a single control request for CROB (group 12):	☒ Fixed at 16 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	16	
1.5.6 Maximum number of objects allowed in a single control request for Analog Outputs (group 41):	☐ Fixed at _ ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	Analog Outputs not supported	
1.5.7 Maximum number of objects allowed in a single control request for Data Sets (groups 85,86,87):	☐ Fixed at __ ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	Data Sets not supported	
1.5.8 Supports mixing object groups (AOBs, CROBs and Data Sets) in the same control request:	☐ Not applicable - controls are not supported ☐ Yes ☒ No	Analog Outputs not supported	

1.6 Fill Out The Following Items For Outstations Only		**Current Value**	**If configurable, list methods**
1.6.1 Timeout waiting for Application Confirm of solicited response message:	☐ None ☒ Fixed at 5,000 ms ☐ Configurable, range _______ to _______ms ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	5,000 ms	
1.6.2 How often is time synchronization required from the master?	☒ Never needs time ☐ Within ______ seconds after IIN1.4 is set ☐ Periodically every _______ seconds		
1.6.3 Device Trouble Bit IIN1.6:	☐ Never used ☒ Reason for setting: Unable to access requested data or execute CROB, assuming a valid request has been received		
1.6.4 File Handle Timeout:	☒ Not applicable, files not supported ☐ Fixed at______ ms ☐ Configurable, range _______ to _______ms ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________		
1.6.5 Event Buffer Overflow Behaviour:	☐ Discard the oldest event ☒ Discard the newest event ☐ Other, explain _________________________		
1.6.6 Event Buffer Organization:	• Single buffer for the Object Groups 2 and 32, size 200. • Separate buffer for the Object Group 111, size 100. • Separate buffer for the Fault Locator events, size 100.		
1.6.7 Sends Multi-Fragment Responses:	☒ Yes ☐ No		
1.6.8 DNP Command Settings preserved through a device reset:	☐ Assign Class ☐ Analog Deadbands ☐ Data Set Prototypes ☐ Data Set Descriptors	Not supported	

1.7 Outstation Unsolicited Response Support		**Current Value**	**If configurable, list methods**
1.7.1 Supports Unsolicited Reporting:	☒ Not Supported ☐ Configurable, selectable from On and Off	NA	

1.8 Outstation Performance		Current Value	If configurable, list methods
1.8.1 Maximum Time Base Drift (milliseconds per minute):		NA, not synchronized by DNP	
1.8.2 When does outstation set IIN1.4?	☒ Never ☐ Asserted at startup until first Time Synchronization request received ☐ Periodically, range ____to____ seconds ☐ Periodically, selectable from ____,____,___ seconds ☐ Range ____to____ seconds after last time sync ☐ Selectable from___,___,___seconds after last time sync ☐ When time error may have drifted by range ____to____ ms ☐ When time error may have drifted by selectable from ____,____,___	NA	
1.8.3 Maximum Internal Time Reference Error when set via DNP (ms):		NA	
1.8.4 Maximum Delay Measurement error (ms):		NA	
1.8.5 Maximum Response time (ms):		100 ms (for the case all supported points mapped to the DNP point lists)	F-PRO Offliner
1.8.6 Maximum time from start-up to IIN 1.4 assertion (ms):		NA	
1.8.7 Maximum Event Time-tag error for local Binary and Double-bit I/O (ms):		• 0.1736 ms for 60Hz systems • 0.2083 ms for 50 Hz systems	
1.8.8 Maximum Event Time-tag error for local I/O other than Binary and Double-bit data types (ms):		• 0.1736 ms for 60Hz systems • 0.2083 ms for 50 Hz systems	

Capabilities and Current Settings for Device Database

The following tables identify the capabilities and current settings for each DNP3 data type. Each data type also provides a table defining the data points available in the device, default point lists configuration and a description of how this information can be obtained in case of customized point configuration.

2.1 Single-Bit Binary Inputs	Capabilities	Current Value	If configurable, list methods
2.1.1 Static Variation reported when variation 0 requested:	☒ Variation 1 - Single-bit Packed format ☐ Variation 2 - Single-bit with flag ☐ Based on point Index (add column to table below)		
2.1.2 Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☒ Variation 2 - with absolute time ☐ Variation 3 - with relative time ☐ Based on point Index (add column to table below)		
2.1.3 Event reporting mode:	☐ Only most recent ☒ All events		
2.1.4 Binary Inputs included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		F-PRO Offliner
2.1.5 Definition of Binary Input Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain_____________________	Complete list is shown in the table below; points excluded from the default configuration are marked with '*'	F-PRO Offliner

Notes	1. Binary Inputs are scanned with 1 ms resolution. 2. Binary Input data points are user selectable; the data points available in the device for any given Binary Input point selection can be obtained through the F-PRO Offliner software (see SCADA Setting Summary).

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Name for State when value is 0	Name for State when value is 1	Description
0	External Input 1	1	Inactive	Active	
1	External Input 2	1	Inactive	Active	
2	External Input 3	1	Inactive	Active	
3	External Input 4	1	Inactive	Active	
4	External Input 5	1	Inactive	Active	
5	External Input 6	1	Inactive	Active	
6	External Input 7	1	Inactive	Active	
7	External Input 8	1	Inactive	Active	
8	External Input 9	1	Inactive	Active	
9	Virtual Input 1	1	Inactive	Active	
10	Virtual Input 2	1	Inactive	Active	
11	Virtual Input 3	1	Inactive	Active	
12	Virtual Input 4	1	Inactive	Active	
13	Virtual Input 5	1	Inactive	Active	
14	Virtual Input 6	1	Inactive	Active	
15	Virtual Input 7	1	Inactive	Active	
16	Virtual Input 8	1	Inactive	Active	
17	Virtual Input 9	1	Inactive	Active	
18	Virtual Input 10	1	Inactive	Active	
19	Virtual Input 11	1	Inactive	Active	
20	Virtual Input 12	1	Inactive	Active	
21	Virtual Input 13	1	Inactive	Active	
22	Virtual Input 14	1	Inactive	Active	
23	Virtual Input 15	1	Inactive	Active	
24	Virtual Input 16	1	Inactive	Active	
25	Virtual Input 17	1	Inactive	Active	
26	Virtual Input 18	1	Inactive	Active	
27	Virtual Input 19	1	Inactive	Active	
28	Virtual Input 20	1	Inactive	Active	
29	Virtual Input 21	1	Inactive	Active	
30	Virtual Input 22	1	Inactive	Active	
31	Virtual Input 23	1	Inactive	Active	

32	Virtual Input 24	1	Inactive	Active	
33	Virtual Input 25	1	Inactive	Active	
34	Virtual Input 26	1	Inactive	Active	
35	Virtual Input 27	1	Inactive	Active	
36	Virtual Input 28	1	Inactive	Active	
37	Virtual Input 29	1	Inactive	Active	
38	Virtual Input 30	1	Inactive	Active	
39	50LS-1 Main Trip	1	Inactive	Active	OR of 50LS-1 Main A, B and C Trip
40	50LS-2 Main Trip	1	Inactive	Active	OR of 50LS-1 Main A, B and C Trip
41	50LS-1 Aux Trip	1	Inactive	Active	OR of 50LS-1 Main A, B and C Trip
42	50LS-2 Aux Trip	1	Inactive	Active	OR of 50LS-1 Main A, B and C Trip
43	50BF-1 Main Trip	1	Inactive	Active	
44	50 BF -2 Main Trip	1	Inactive	Active	
45	50BF-1 Aux Trip	1	Inactive	Active	
46	50 BF -2 Aux Trip	1	Inactive	Active	
47	25/27/59 Sync Check	1	Inactive	Active	
48	79 Main Output	1	Inactive	Active	
49	79 Aux Output	1	Inactive	Active	
50	50 Trip	1	Inactive	Active	
51	51 Alarm	1	Inactive	Active	
52	51 Trip	1	Inactive	Active	
53	50N Trip	1	Inactive	Active	
54	51N Alarm	1	Inactive	Active	
55	51N Trip	1	Inactive	Active	
56	46-50 Trip	1	Inactive	Active	
57	46-51 Alarm	1	Inactive	Active	
58	46-51 Trip	1	Inactive	Active	
59	32P Trip	1	Inactive	Active	
60	32Q Trip	1	Inactive	Active	
61	59-1 Trip	1	Inactive	Active	OR of 59-1 A, B and C Trip
62	59-2 Trip	1	Inactive	Active	OR of 59-1 A, B and C Trip
63	27-1 Trip	1	Inactive	Active	OR of 59-1 A, B and C Trip

64	27-1 Trip	1	Inactive	Active	OR of 59-1 A, B and C Trip
65	60 Alarm	1	Inactive	Active	OR of 59-1 A, B and C Trip
66	81-1 Trip	1	Inactive	Active	
67	81-2 Trip	1	Inactive	Active	
68	81-3 Trip	1	Inactive	Active	
69	81-4 Trip	1	Inactive	Active	
70	THD Alarm	1	Inactive	Active	
71	Self Check Fail	1	Inactive	Active	OR of 27 Main A, B and C Trip
72	79 Initiate	1	Inactive	Active	OR of 27 Aux A, B and C Trip
73	79 Block	1	Inactive	Active	OR of 59 Main A, B and C Trip
74	79 Main Lockout	1	Inactive	Active	OR of 59 Aux A, B and C Trip
75	79 Aux Lockout	1	Inactive	Active	OR of 50LS Main A, B and C Trip
76	BF Initiated	1	Inactive	Active	OR of 50LS Aux A, B and C Trip
77	50G-1 Trip	1	Inactive	Active	
78	50G-2 Trip	1	Inactive	Active	
79	51G Alarm	1	Inactive	Active	OR of 81-1 OF, UF and FRC Trip
80	51GTrip	1	Inactive	Active	OR of 81-2 OF, UF and FRC Trip
81	ProLogic1	1	Inactive	Active	OR of 81-3 OF, UF and FRC Trip
82	ProLogic2	1	Inactive	Active	OR of 81-4 OF, UF and FRC Trip
83	ProLogic3	1	Inactive	Active	
84	ProLogic4	1	Inactive	Active	
85	ProLogic5	1	Inactive	Active	
86	ProLogic6	1	Inactive	Active	
87	ProLogic7	1	Inactive	Active	
88	ProLogic8	1	Inactive	Active	
89	ProLogic9	1	Inactive	Active	
90	ProLogic10	1	Inactive	Active	
91	Breaker Logic1	1	Inactive	Active	
92	Breaker Logic2	1	Inactive	Active	

93	Breaker Logic3	1	Inactive	Active	
94	Breaker Logic4	1	Inactive	Active	
95	Breaker Logic5	1	Open	Closed	
96	Breaker Logic6	1	Open	Closed	
97	Breaker Logic7	1	Open	Closed	
98	Breaker Logic8	1	Open	Closed	
99	Breaker Logic9	1	Open	Closed	
100	Breaker Logic10	1	Open	Closed	
101*	Output Contact 1	1	Open	Closed	
102*	Output Contact 2	1	Open	Closed	
103*	Output Contact 3	1	Open	Closed	
104*	Output Contact 4	1	Open	Closed	
105*	Output Contact 5	1	Open	Closed	
106*	Output Contact 6	1	Open	Closed	
107*	Output Contact 7	1	Open	Closed	
108*	Output Contact 8	1	Open	Closed	
109*	Output Contact 9	1	Open	Closed	
110*	Output Contact 10	1	Open	Closed	
111*	Output Contact 11	1	Open	Closed	
112*	Output Contact 12	1	Open	Closed	
113*	Output Contact 13	1	Open	Closed	
114*	Output Contact 14	1	Open	Closed	
115*	27-1 A Trip	1	Open	Closed	
116*	27-1 B Trip	1	Inactive	Active	
117*	27-1 C Trip	1	Inactive	Active	
118*	27-2 A Trip	1	Inactive	Active	
119*	27-2 B Trip	1	Inactive	Active	
120*	27-2 C Trip	1	Inactive	Active	
121*	59-1 A Trip	1	Inactive	Active	
122*	59-1 B Trip	1	Inactive	Active	
123*	59-1 C Trip	1	Inactive	Active	
124*	59-2 A Trip	1	Inactive	Active	
125*	59-2 B Trip	1	Inactive	Active	
126*	59-2 C Trip	1	Inactive	Active	
127*	50LS-1 Main A Trip	1	Inactive	Active	
128*	50LS-1 Main B Trip	1	Inactive	Active	

129*	50LS-1 Main C Trip	1	Inactive	Active	
130*	50LS-2 Main A Trip	1	Inactive	Active	
131*	50LS-2 Main B Trip	1	Inactive	Active	
132*	50LS-2 Main C Trip	1	Inactive	Active	
133*	50LS-1 Aux A Trip	1	Inactive	Active	
134*	50LS-1 Aux B Trip	1	Inactive	Active	
135*	50LS-1 Aux C Trip	1	Inactive	Active	
136*	50LS-2 Aux A Trip	1	Inactive	Active	
137*	50LS-2 Aux B Trip	1	Inactive	Active	
138*	50LS-2 Aux C Trip	1	Inactive	Active	
139*	60 A Alarm	1	Inactive	Active	
140*	60 B Alarm	1	Inactive	Active	
141*	60 C Alarm	1	Inactive	Active	

2.2 Binary Output Status And Control Relay Output Block	**Capabilities**	**Current Value**	**If configurable, list methods**
2.2.1 Minimum pulse time allowed with Trip, Close, and Pulse On commands:	☒ Fixed at 0.000 ms (hardware may limit this further) ☐ Based on point Index (add column to table below)		
2.2.2 Maximum pulse time allowed with Trip, Close, and Pulse On commands:	☒ Fixed at 0.000 ms (hardware may limit this further) ☐ Based on point Index (add column to table below)		
2.2.3 Binary Output Status included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		
2.2.4 Reports Output Command Event Objects:	☒ Never ☐ Only upon a successful Control ☐ Upon all control attempts	Not supported	
2.2.5 Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☐ Variation 2 - with absolute time ☐ Based on point Index (add column to table below)	Not supported	F-PRO Offliner (See Note 2 below)
2.2.6 Command Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☐ Variation 2 - with absolute time ☐ Based on point Index (add column to table below)	Not supported	F-PRO Offliner (See Note 2 below)
2.2.7 Event reporting mode:	☐ Only most recent ☐ All events	Not supported	F-PRO Offliner (See Note 2 below)
2.2.8 Command Event reporting mode:	☐ Only most recent ☐ All events	Not supported	
2.2.9 Maximum Time between Select and Operate:	☐ Not Applicable ☒ Fixed at 10 seconds ☐ Configurable, range ______ to ______ seconds ☐ Configurable, selectable from___,___,___seconds ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________ ☐ Based on point Index (add column to table below)	10 s	
2.2.10 Definition of Binary Output Status/Control relay output block (CROB) Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain_____________________	Complete list is shown in the table below; points excluded from the default configuration are marked with '*'	F-PRO Offliner

NOTES	
	1. Binary Outputs are scanned with 500 ms resolution. 2. Events are not supported for Binary Outputs (group 10), but most of Binary Output points can be mapped to Binary Inputs (group 2) with full Event and Class Data support. See F-PRO Offliner/DNP Configuration/Point Map screen for complete point lists and configuration options. 3. Virtual Inputs (default Binary Output points 94-123) can be used to control relay output contacts. See F-PRO Offliner/Setting Group X/Output Matrix screen for configuration options. 4. Binary Output data points are user selectable; the data points available in the device for any given Binary Output point selection can be obtained through the F-PRO Offliner software (see SCADA Setting Summary).

Point Index	Name	Supported Control Operations											Name for State when value is 0	Name for State when value is 1	Default Class Assigned to Events (1, 2, 3 or none)		Description
		Select/Operate	Direct Operate	Direct Operate - No Ack	Pulse On / NUL	Pulse Off	Latch On / NUL	Latch Off / NUL	Trip	Close	Count > 1	Cancel Currently Running Operation			Change	Command	
0	Output contact 1	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
1	Output contact 2	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
2	Output contact 3	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
3	Output contact 4	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
4	Output contact 5	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
5	Output contact 6	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
6	Output contact 7	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
7	Output contact 8	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
8	Output contact 9	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
9	Output contact 10	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
10	Output contact 11	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
11	Output contact 12	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
12	Output contact 13	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
13	Output contact 14	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
14	Virtual Input 1	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
15	Virtual Input 2	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
16	Virtual Input 3	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
17	Virtual Input 4	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
18	Virtual Input 5	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s

		Supported Control Operations													Default Class Assigned to Events (1, 2, 3 or none)		
Point Index	Name	Select/Operate	Direct Operate	Direct Operate - No Ack	Pulse On / NUL	Pulse Off	Latch On / NUL	Latch Off / NUL	Trip	Close	Count > 1	Cancel Currently Running Operation	Name for State when value is 0	Name for State when value is 1	Change	Command	Description
19	Virtual Input 6	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
20	Virtual Input 7	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
21	Virtual Input 8	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
22	Virtual Input 9	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
23	Virtual Input 10	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
24	Virtual Input 11	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
25	Virtual Input 12	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
26	Virtual Input 13	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
27	Virtual Input 14	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
28	Virtual Input 15	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
29	Virtual Input 16	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
30	Virtual Input 17	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
31	Virtual Input 18	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
32	Virtual Input 19	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
33	Virtual Input 20	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
34	Virtual Input 21	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
35	Virtual Input 22	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
36	Virtual Input 23	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
37	Virtual Input 24	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
38	Virtual Input 25	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
39	Virtual Input 26	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
40	Virtual Input 27	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
41	Virtual Input 28	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
42	Virtual Input 29	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
43	Virtual Input 30	Y	Y	Y	Y	-	Y	-	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
44	I2*t Main Reset	Y	Y	Y	Y	-	Y	-	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s

Point Index	Name	Supported Control Operations											Name for State when value is 0	Name for State when value is 1	Default Class Assigned to Events (1, 2, 3 or none)		Description
		Select/Operate	Direct Operate	Direct Operate - No Ack	Pulse On / NUL	Pulse Off	Latch On / NUL	Latch Off / NUL	Trip	Close	Count > 1	Cancel Currently Running Operation			Change	Command	
45	I2*t Aux. Reset	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
46	Reset Energy	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
47	Reset Breaker Logic 1	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
48	Reset Breaker Logic 2	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
49	Reset Breaker Logic 3	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
50	Reset Breaker Logic 4	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
51	Reset Breaker Logic 5	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
52	Reset Breaker Logic 6	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
53	Reset Breaker Logic 7	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
54	Reset Breaker Logic 8	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
55	Reset Breaker Logic 9	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
56	Reset Breaker Logic 10	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
57	Demand reset	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
58	Peak Demand Reset	Y	Y	Y	Y	-	Y	Y	-	-		-	Inactive	Active	None	None	Pulse duration fixed at 1 s

2.3 Analog Input Points	**Capabilities**	**Current Value**	**If configurable, list methods**
2.3.1 Static Variation reported when variation 0 requested:	☐ Variation 1 - 32-bit with flag ☐ Variation 2 - 16-bit with flag ☐ Variation 3 - 32-bit without flag ☒ Variation 4 - 16-bit without flag ☐ Variation 5 - single-precision floating point with flag ☐ Variation 6 - double-precision floating point with flag ☐ Based on point Index (add column to table below)		
2.3.2 Event Variation reported when variation 0 requested:	☐ Variation 1 - 32-bit without time ☒ Variation 2 - 16-bit without time ☐ Variation 3 - 32-bit with time ☐ Variation 4 - 16-bit with time ☐ Variation 5 - single-precision floating point w/o time ☐ Variation 6 - double-precision floating point w/o time ☐ Variation 7 - single-precision floating point with time ☐ Variation 8 - double-precision floating point with time ☐ Based on point Index (add column to table below)		
2.3.3 Event reporting mode:	☐ Only most recent ☒ All events		
2.3.4 Analog Inputs Included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		
2.3.5 How Deadbands are set:	☐ A. Global Fixed ☐ B. Configurable through DNP ☒ C. Configurable via other means ☐ D. Other, explain ________________________ ☐ Based on point Index - column specifies which of the options applies, B, C, or D		F-PRO Offliner
2.3.6 Analog Deadband Algorithm: simple - just compares the difference from the previous reported value	☒ Simple ☐ Integrating ☐ Other, explain __________________________		
2.3.7 Definition of Analog Input Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain_____________________	Complete list is shown in the table below; points excluded from the default configuration are marked with '*'	F-PRO Offliner

NOTES	1. Analog Inputs are scanned with 500 ms resolution. 2. Nominal values in calculations for the following table are based on 69V secondary voltage * PT ratio for voltage channels, and either 1 A or 5A secondary current * CT ratio for current channels dependent upon the format of CT installed in the F-PRO. 3. Analog Input data points are user selectable; the data points available in the device for any given Analog Input point selection can be obtained through the F-PRO Offliner software (see SCADA Setting Summary).

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value[a]		Scaling[b]		Units	Resolution[c] (default/ maximal)	Description
			Minimum	Maximum[d]	Multiplier (default/ (range))	Offset			
0	Main Va Magnitude	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	kV	0.1 / 0.00001	
1	Main Va Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
2	Main Vb Magnitude	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	kV	0.1 / 0.00001	
3	Main Vb Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
4	Main Vc Magnitude	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	kV	0.1 / 0.00001	
5	Main Vc Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
6	Main Ia Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
7	Main Ia Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
8	Main Ib Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
9	Main Ib Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
10	Main Ic Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
11	Main Ic Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
12	Aux Ia Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
13	Aux Ia Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
14	Aux Ia Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
15	Aux Ia Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
16	v Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
17	Aux Ia Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
18	Line Ia Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
19	Line Ia Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
20	Line Ib Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
21	Line Ib Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
22	Line Ic Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
23	Line IcAngle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
24	Sync V Magnitude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
25	Sync V Angle	2	-18,000	Configurable	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	
26	P	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MW	0.1 / 0.00001	
27	Q	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MVar	0.1 / 0.00001	
28	Pos Seq Voltage	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	kV	0.1 / 0.00001	
29	Pos Seq Current	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
30	Frequency	2	0	Configurable	0.01 / (0.001 - 1.0)	0.0	Hz	0.01 / 0.001	
31	THD	2	0	Configurable	0.01 / (0.01- 1.0)	0.0	%	0.01 / 0.01	

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value[a]		Scaling[b]		Units	Resolution[c] (default/ maximal)	Description
			Minimum	Maximum[d]	Multiplier (default/ (range))	Offset			
32	Active Setting Group Number	2	1	Configurable	1.0	0.0	N/A	1.0	
33	Demand Power Out	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MW	0.1 / 0.00001	
34	Demand Power In	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MW	0.1 / 0.00001	
35	Demand Reactive Power Out	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MVar	0.1 / 0.00001	
36	Demand Reactive Power In	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MVar	0.1 / 0.00001	
37	Demand Va	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	kV	0.1 / 0.00001	
38	Demand Vb	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	kV	0.1 / 0.00001	
39	Demand Vc	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	kV	0.1 / 0.00001	
40	Demand Ia	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
41	Demand Ib	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
42	Demand Ic	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
43	Demand System Frequency	2	0	Configurable	0.01 / (0.001 - 1.0)	0.0	Hz	0.01 / 0.001	
44	Demand Max. THD among all current	2	0	Configurable	0.01 / (0.01- 1.0)	0.0	%	0.01 / 0.01	
45	3-phase MWh Out	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MWh	0.1 / 0.00001	
46	3-phase MWh IN	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MWh	0.1 / 0.00001	
47	3-phase MVARh Out	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MVarh	0.1 / 0.00001	
48	3-phase MVARh IN	2	0	Configurable	0.1 / (0.00001- 1.0)	0.0	MVarh	0.1 / 0.00001	
49	Breaker Logic1 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
50	Breaker Logic2 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
51	Breaker Logic3 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
52	Breaker Logic4 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
53	Breaker Logic5 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
54	Breaker Logic6 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	NA	1.0 /1.0	
55	Breaker Logic7 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
56	Breaker Logic8 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
57	Breaker Logic9 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
58	Breaker Logic10 Count	2	0	Configurable	1.0 / (1.0 - 10.0)	0.0	N/A	1.0 /1.0	
59	I2*t Main Accumu-lated	2	0	Configurable	0.001 / (0.001 - 1.0)		(kA)2*s	0.001 / 0.001	
60	I2*t Main for last operation	2	0	Configurable	0.001 / (0.001 - 1.0)		(kA)2*s	0.001 / 0.001	
61	I2*t Aux. Accumu-lated	2	0	Configurable	0.001 / (0.001 - 1.0)		(kA)2*s	0.001 / 0.001	
62	I2*t Aux. for last operation	2	0	Configurable	0.001 / (0.001 - 1.0)		(kA)2*s	0.001 / 0.001	
63	Ground Ig Magni-tude	2	0	Configurable	1.0 / (0.01 - 1000)	0.0	A	1.0 / 0.01	
64	Ground Ig Angle	2	-18,000	18,000	0.1 / (0.01 - 1.0)	0.0	Degrees	0.1 / 0.01	

a. The minimum and maximum transmitted values are the lowest and highest values that the outstation will report in DNP analog input objects. These values are integers if the outstation transmits only integers. If the outstation is capable of transmitting both integers and floating-point, then integer and floating-point values are required for the minimums and maximums.
   For example, a pressure sensor is able to measure 0 to 500 kPa. The outstation provides a linear conversion of the sensor's output signal to integers in the range of 0 to 25000 or floating-point values of 0 to 500.000. The sensor and outstation are used in an application where the maximum possible pressure is 380 kPa. For this input, the minimum transmitted value would be stated as 0 / 0.0 and the maximum transmitted value would be stated as 19000 / 380.000.
b. The scaling information for each point specifies how data transmitted in integer variations (16 bit and 32 bit) is converted to engineering units when received by the Master (i.e. scaled according to the equation: scaled value = multiplier * raw + offset). Scaling is not applied to Floating point variations since they are already transmitted in engineering units.
c. Resolution is the smallest change that may be detected in the value due to quantization errors and is given in the units shown in the previous column. This parameter does not represent the accuracy of the measurement.
d. Maximal values are calculated as (2 * Configured Nominal / Multiplier) for voltage channels and as (40 * Configured Nominal / Multiplier) for current channels (see Note 2 above for the nominal definitions).

2.4 Octet String Points	**Capabilities**	**Current Value**	**If configurable, list methods**
2.4.1 Event reporting mode *:	☐ Only most recent ☒ All events		
2.4.2 Octet Strings Included in Class 0 response:	☐ Always ☒ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		
2.4.3 Definition of Octet String Point List:	☐ Fixed, list shown in table below ☐ Configurable (current list may be shown in table below) ☒ Other, explain <u>Used for Event Log access as described below</u>		

* Object 110 and 111 are Octet String Object used to provide access to the Event Log text of the relay. Object 110 always contains the most recent event in the relay. Object 111 is the corresponding change event object.

As stated in the DNP specifications, the variation of the response object represents the length of the string. The string represents the ASCII values of the event text. The first two characters in the string can be used to quickly identify fault location events. Fault locator events begin with the characters "FL" (0x46, 0x4C hex). The following example shows a fault distance event returned through either of the octet string objects:

Event Message:

FL2000Sep21 20:16:16.966: 21P1 AB 1.0km: Trip

DNP Octet string object components:					
0x20	0x20	0x31	0x39	0x39	0x39
0x44	0x65	0x63	0x30	0x38	0x20
0x30	0x37	0x3A	0x32	0x37	0x3A
0x35	0x35	0x2E	0x32	0x34	0x38
0x20	0x3A	0x20	0x32	0x37	0x2D
0x32	0x20	0x28	0x55	0x2F	0x56
0x29	0x20	0x6F	0x6E	0x20	0x41
0x42	0x43	0x3A	0x20	0x54	0x72
0x69	0x70				

Implementation Table

The following implementation table identifies which object groups and variations, function codes and qualifiers the device supports in both requests and responses. The Request columns identify all requests that may be sent by a Master, or all requests that must be parsed by an Outstation. The Response columns identify all responses that must be parsed by a Master, or all responses that may be sent by an Outstation.

NOTE	The implementation table must list all functionality required by the device whether Master or Outstation as defined within the DNP3 IED Conformance Test Procedures. Any functionality beyond the highest subset level supported is indicated by highlighted rows. Any Object Groups not provided by an outstation or not processed by a Master are indicated by ~~strikethrough~~ (note these Object Groups will still be parsed).

DNP Object Group & Variation			**Request** Outstation parses		**Response** Outstation can issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
1	0	Binary Input - Any Variation	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
1	1	Binary Input - Packed format	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
1	2	Binary Input - With flags	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
2	0	Binary Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
2	1	Binary Input Event - Without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
2	2	Binary Input Event - With absolute time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
2	3	Binary Input Event - With relative time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
10	0	Binary Output - Any Variation	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
10	2	Binary Output - Output Status with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
12	1	Binary Command - Control relay output block (CROB)	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	Echo of request

DNP Object Group & Variation			Request Outstation parses		Response Outstation can issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
20	0	~~Counter - Any Variation~~	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)	129 (response)	
20	1	~~Counter - 32-bit with flag~~			129 (response)	~~00, 01 (start-stop)~~
20	2	~~Counter - 16-bit with flag~~			129 (response)	~~00, 01 (start-stop)~~
20	5	~~Counter - 32-bit without flag~~			129 (response)	~~00, 01 (start-stop)~~
20	6	~~Counter - 16-bit without flag~~			129 (response)	~~00, 01 (start-stop)~~
21	0	~~Frozen Counter - Any Variation~~	1 (read)	06 (no range, or all)		
21	1	~~Frozen Counter - 32-bit with flag~~			129 (response)	~~00, 01 (start-stop)~~
21	2	~~Frozen Counter - 16-bit with flag~~			129 (response)	~~00, 01 (start-stop)~~
21	9	~~Frozen Counter - 32-bit without flag~~			129 (response)	~~00, 01 (start-stop)~~
21	10	~~Frozen Counter - 16-bit without flag~~			129 (response)	~~00, 01 (start-stop)~~
22	0	~~Counter Event - Any Variation~~	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
22	1	~~Counter Event - 32-bit with flag~~			129 (response) ~~130 (unsol. resp)~~	~~17, 28 (index)~~
22	2	~~Counter Event - 16-bit with flag~~			129 (response) ~~130 (unsol. resp)~~	~~17, 28 (index)~~
30	0	Analog Input - Any Variation	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	1	Analog Input - 32-bit with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	2	Analog Input - 16-bit with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	3	Analog Input - 32-bit without flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	4	Analog Input - 16-bit without flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
32	0	Analog Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	1	Analog Input Event - 32-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
32	2	Analog Input Event - 16-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
32	3	Analog Input Event - 32-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	4	Analog Input Event - 16-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
40	0	~~Analog Output Status - Any Variation~~	1 (read)	06 (no range, or all)	129 (response)	

DNP Object Group & Variation			Request Outstation parses		Response Outstation can issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
40	2	~~Analog Output Status - 16-bit with flag~~			129 (response)	~~00, 01 (start-stop)~~
41	2	~~Analog Output - 16-bit~~	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	~~Echo of request~~
50	1	~~Time and Date - Absolute time~~	2 (write)	07 (limited qty = 1)	129 (response)	
51	1	~~Time and Date CTO - Absolute time, synchronized~~			~~129 (response)~~ ~~130 (unsol. resp)~~	~~07 (limited qty)~~ ~~(qty = 1)~~
51	2	Time and Date CTO - Absolute time, unsynchronized			129 (response) ~~130 (unsol. resp)~~	07 (limited qty) (qty = 1)
52	1	Time Delay - Coarse			129 (response)	07 (limited qty) (qty = 1)
52	2	~~Time delay - Fine~~			~~129 (response)~~	~~07 (limited qty)~~ ~~(qty = 1)~~
60	1	Class Objects - Class 0 data	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
60	2	Class Objects - Class 1 data	1 (read)	06 (no range, or all)	129 (response)	17, 28 (index)
60	3	Class Objects - Class 2 data	1 (read)	06 (no range, or all)	129 (response)	17, 28 (index)
60	4	Class Objects - Class 3 data	1 (read)	06 (no range, or all)	129 (response)	17, 28 (index)
80	1	Internal Indications - Packet format	2 (write)	00 (start-stop) (index = 7)	129 (response)	
110	0	Octet string	1 (read)	06 (no range, or all)	129 (response)	07 (limited qty)
111	0	Octet string event	1 (read)	06 (no range, or all)	129 (response)	07 (limited qty)
No Object (function code only)			13 (cold restart)		129 (response)	
No Object (function code only)			14 (warm restart)		129 (response)	
No Object (function code only)			23 (delay meas.)		129 (response)	

Appendix G Mechanical Drawings

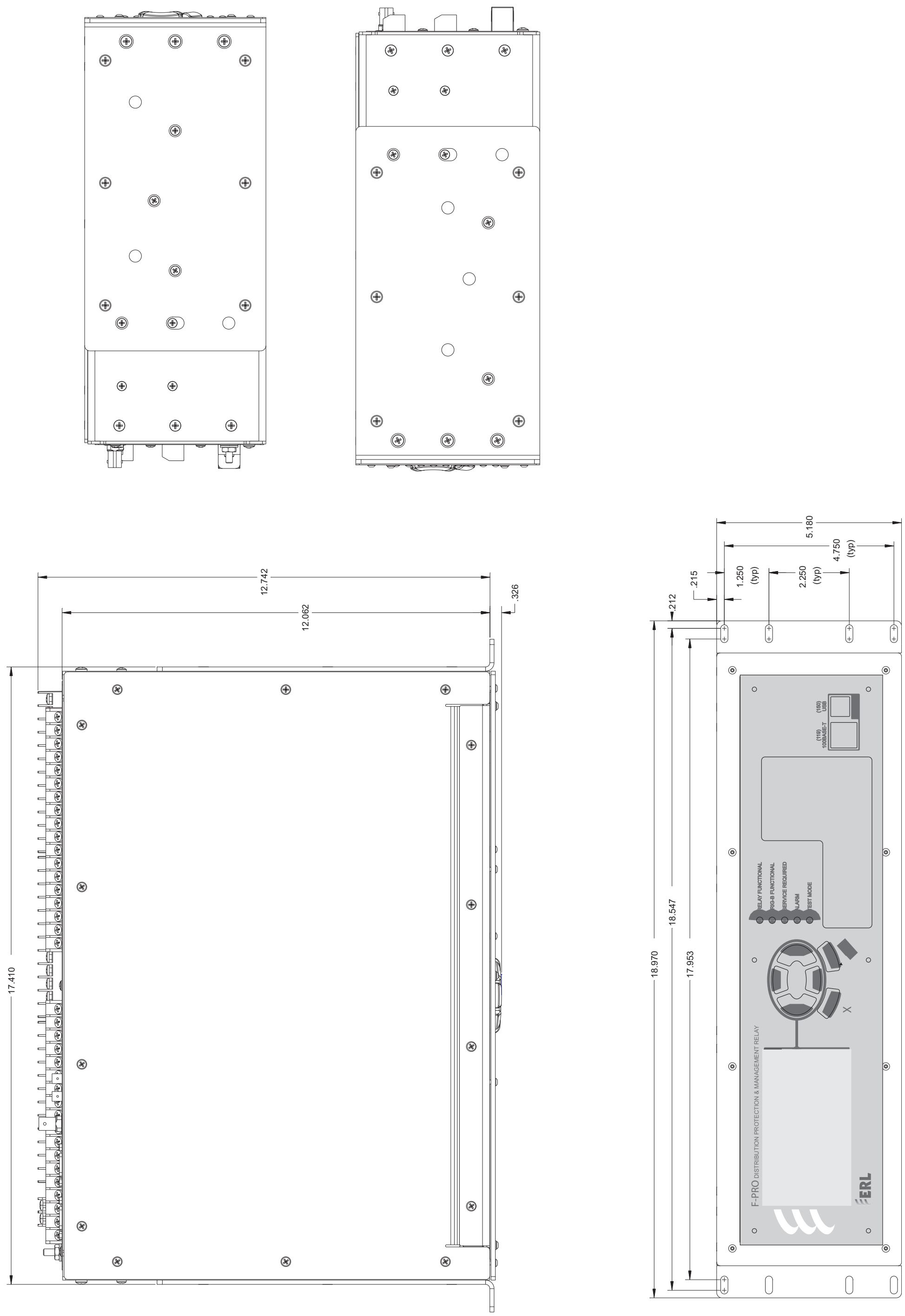


Figure G.1: Mechanical Drawing

Appendix H Rear Panel Drawings

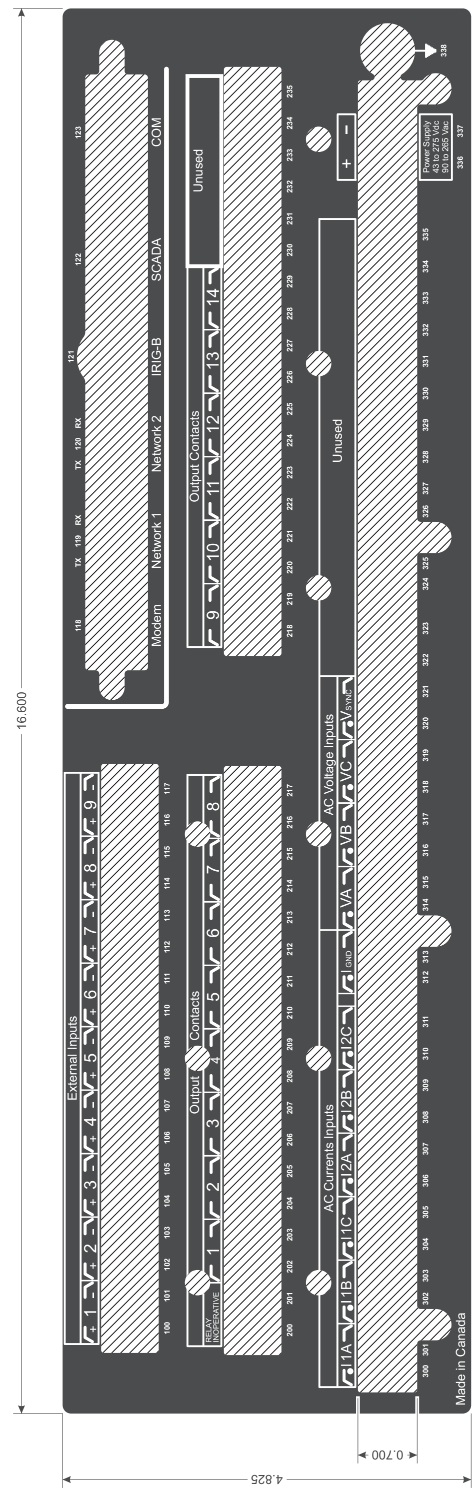


Figure H.1: Rear Panel

Appendix I AC Schematic Drawing

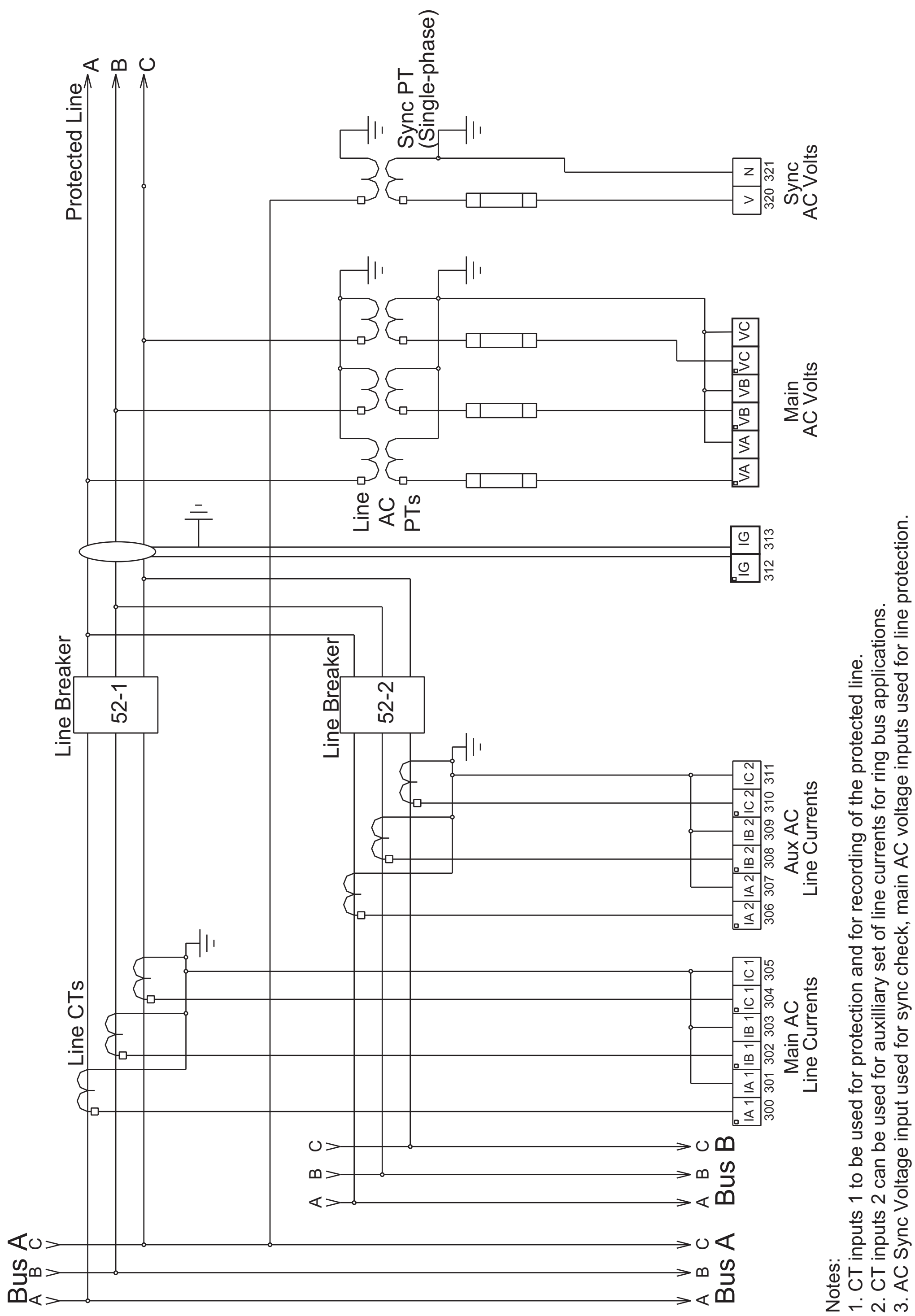
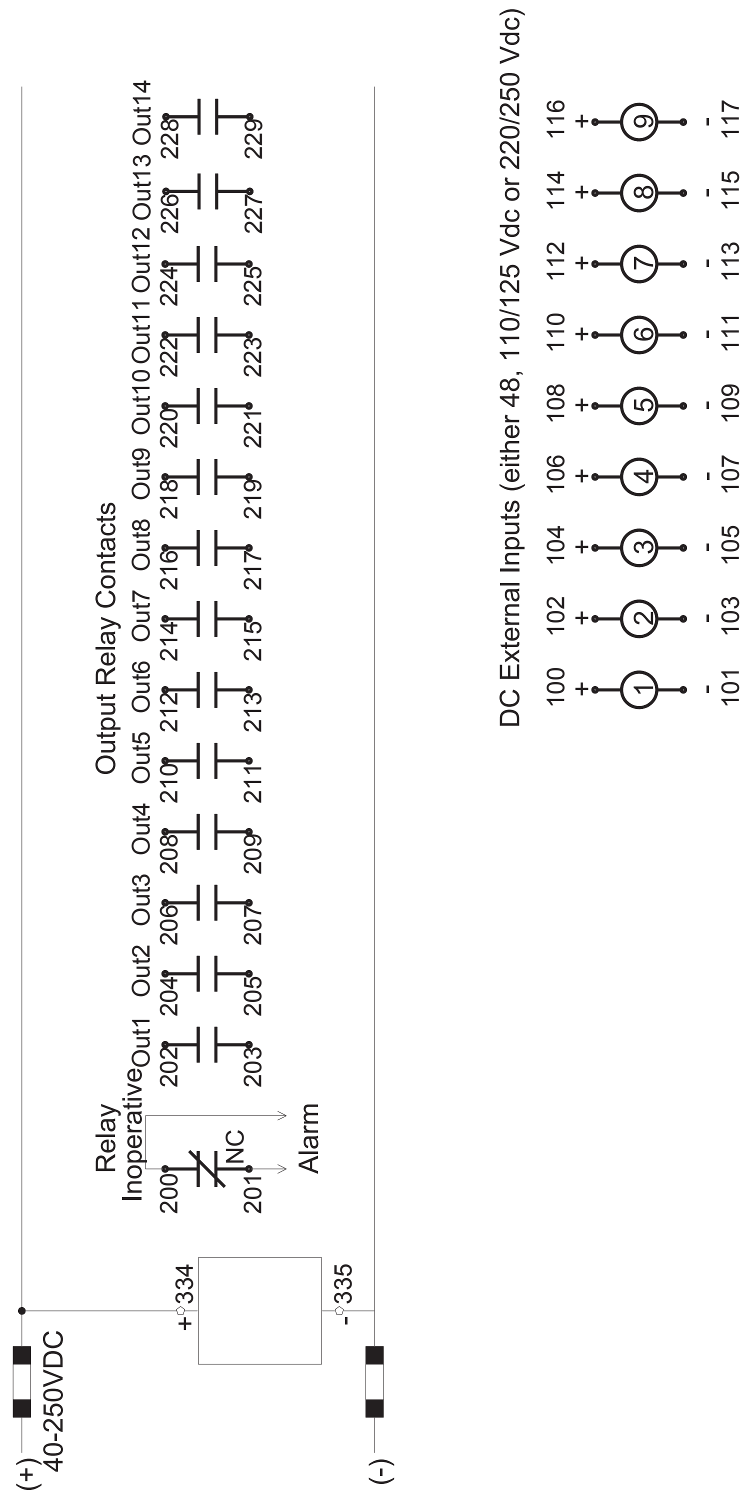


Figure I.1: F-PRO AC Schematic

Appendix J DC Schematic Drawing



Notes:
1. IRIG-B and comm ports shown separately on F-PRO rear panel layout drawing # 371003.
2. All output relays can be programmed to operate on any relay function.
3. All outputs are rated tripping duty, interrupting via breaker aux "a" contact.

Figure J.1: F-PRO DC Schematic

Appendix K Function Logic Diagram

Diagram in plastic sleeve.

Appendix L F-PRO Setting Example

Protection, Timers and I/O Status

The relay does not block any protection functions or external inputs during the setting save or active group change, but the external output contacts are reset for one cycle.

The relay applies the setting parameters, resets all protection functions, resets all timers and continues to process the protection algorithms but does not apply any action to the output contacts for one cycle. For close-in (heavy) fault conditions that occur at the time of a setting change the relay performance has a maximum increase in output delay of one cycle. For light fault conditions the relay performance does not have a noticeable change. There is normally a one cycle decision making process. The relay algorithms have been processing and when the one cycle blocking ends and the contacts are closed immediately (+3ms hardware delay).

Latch Status

The relay does not reset any ProLogic, Group Logic or Virtual Input latch functions during the setting save or active group change. Retaining latch status allows the relay continuous access to specific latched logic states. This is useful when the relay has ProLogic, Group Logic or Virtual Input functions used to block protection or ancillary functions for specific operating conditions.

Event Status Reset

The relay resets all the events that are currently high and reports states of all the events that remain high after a setting change.

Viewing Active Setting Group

To view active setting group via the RCP, Utilities/Setting Group. It is configurable only through service/change Login.

Front Panel Active Setting Group

View the active setting group with the relay front panel display. The active setting group can be changed through the front panel of the relay.

To view the active setting group enter *Utilities/Maintenance/Setting Group Control.*

Flash Memory Write

The flash memory on the main processor board is capable of approximately one hundred thousand erases. The retention of the active setting group causes 2 bytes to be written to a memory block in the flash. Each memory block writes about 65 Kbytes before an erase is performed on the flash memory. An average of 14 setting group changes per day for the 25 year life of a relay results in the flash memory being erased only four times. Latch states from ProLogic and Group Logic also performs writes to the flash memory increasing the number of erases performed on the flash.

L.1 Setting Examples

Breaker Monitor Examples Using Breaker Logic

Clearing Time Monitoring

Definition – The breaker clearing time is the elapsed time from trip coil energized until last phase current is zero.

Desired Behavior – Alarm if the elapsed time is greater than the Clearing Time Pickup Threshold (T1) and the current flowing through the breaker had dropped below the 50LS setting. The logged event message includes the actual clearing time (Timer 1 accumulated run time). When the final output goes high, the run time associated with all the timers is available and can be recorded in the event log. The message parameter setting is used to define the event log message.

In this example a latch gate is used to keep the Breaker logic output condition present until Virtual Input 1 is pulsed high. An alternative setting could be applied where no latch gate is used and T2 drop out timer is set for creating the desired Alarm pulse width.

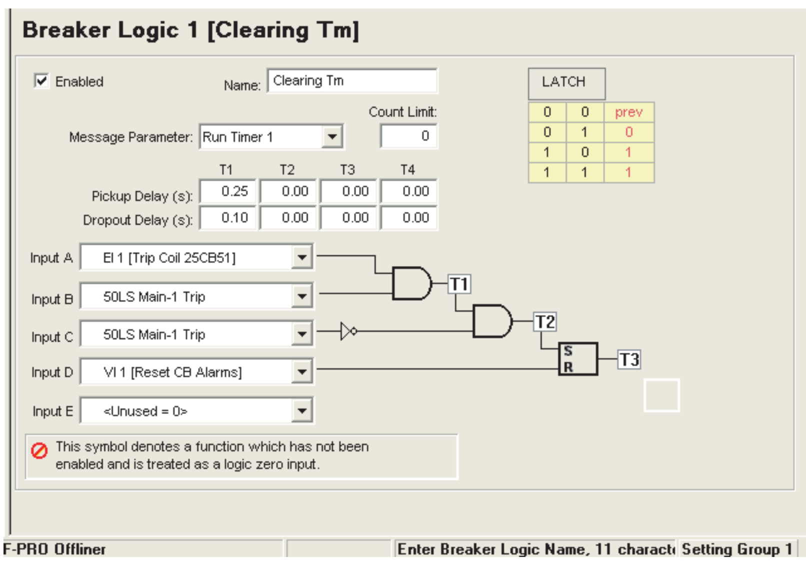


Figure L.1: Breaker Logic 1

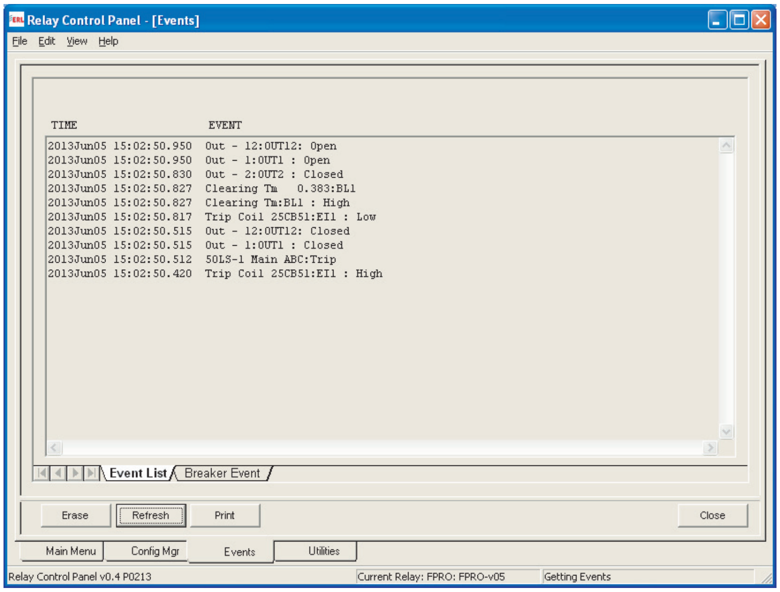


Figure L.2: Event Log

Operations Count Monitoring

Definition – The breaker operations count since last reset/preset.

Desired Behavior – Alarm if the counter is greater than the Count Limit Pickup. Timer T1 pickup delay is used to provide a de-bounce time for the circuit breaker 52a contact. Timer T2 drop out delay is set to one second, for creating the desired Alarm pulse width.

The message parameter setting is used to define the event log message.

In this example T2 drop out timer is set for creating the desired breaker logic output pulse width. An alternative setting could be applied with a latch gate to keep the alarm condition present until Virtual Input 1 is pulsed high.

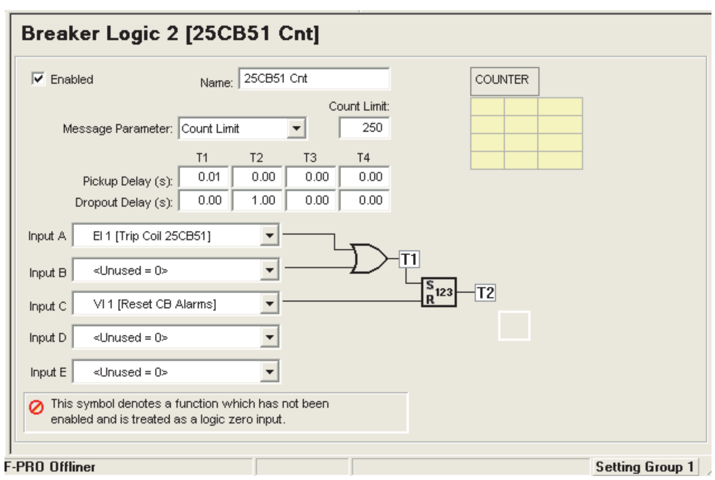


Figure L.3: Breaker Logic 2

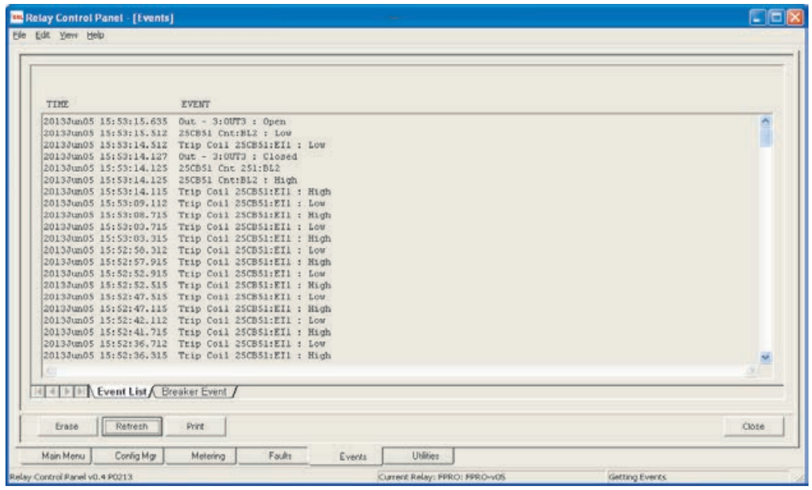


Figure L.4: Event Log

Re-Strike Monitoring

Definition – The fault current appears through the breaker within a set time after fault clearing.

Desired Behavior – Alarm if the fault current appears quicker than the settling time as defined by timer T1 drop out delay, after fault clearing has taken place. Timer T2 drop out delay is set to one second, for creating the desired Alarm pulse width. The message parameter setting is used to define the event log message, this example you do not need any additional information to be included with the event message therefore the message parameter setting equals none.

In this example T2 drop out timer is set for creating the desired breaker logic output pulse width. An alternative setting could be applied with a latch gate to keep the alarm condition present until Virtual Input 1 is pulsed high.

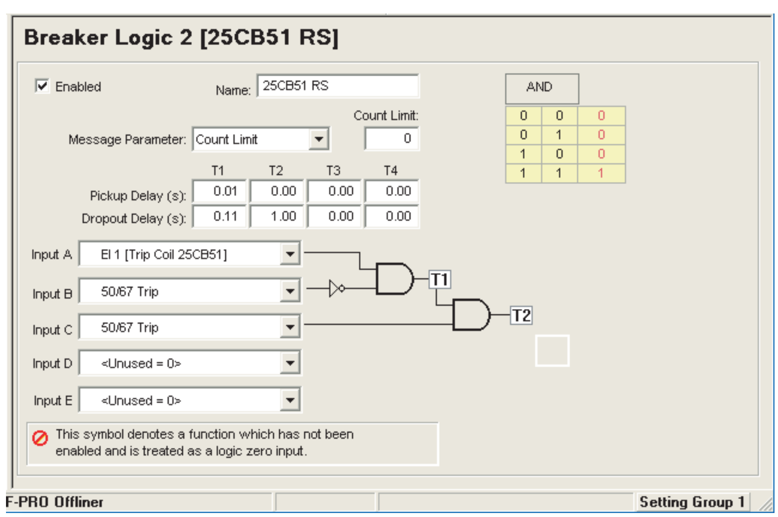


Figure L.5: Breaker Logic 3

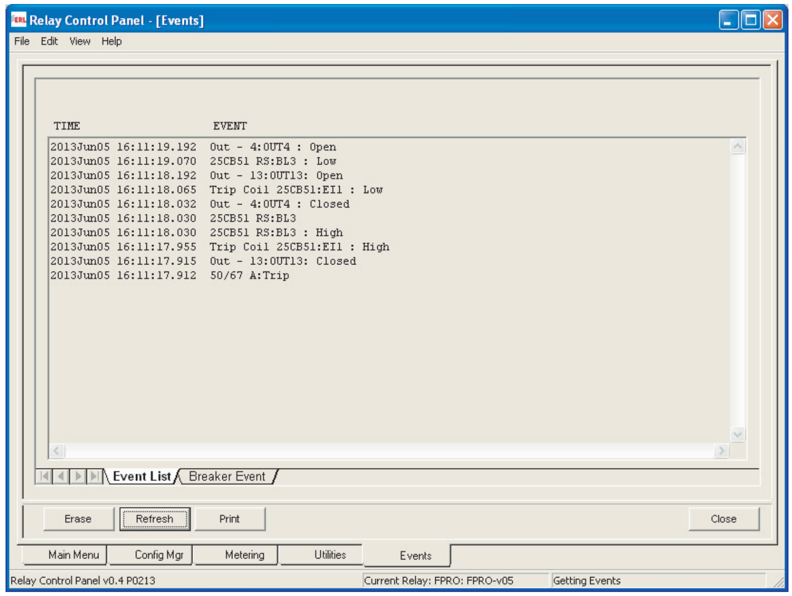


Figure L.6: Event Log

L.2 Switching Setting Groups

You can program a total of sixteen Group Logic statements per setting group to cause a setting change from one group to another. Create settings using the Offliner setting software.

An example of pulsing an external input and an example of a solid initiate to activate setting group changes are shown below.

Using One External Input to Toggle Setting Group

Use one external input connected to a SCADA output contact to toggle between two or more setting groups. In this example we connect external input one (EI 1) to the SCADA control output contact and switch between group one and group two. If you wanted to switch through all setting groups, group logic two would switch to setting group three, and so forth. If the contact input to switch setting groups becomes welded shut or the SCADA system has a problem, the relay will only switch to the new logic and stay in that logic until the input has been de-energized for the ProLogic pickup delay, which was set to 10 seconds.

Setting Group 1 – Logic Statements

When setting group one becomes active either through a setting group change or is the default group after relay power up, ProLogic 9 becomes high after the 10.00 second delay, if EI 1 is low. ProLogic 9 is set for a 0.26 second dropout time; to be used with ProLogic 10 dropout timer allowing for the slower processing thread where Group Logic is processed and providing a definite timed pulse to the group logic.

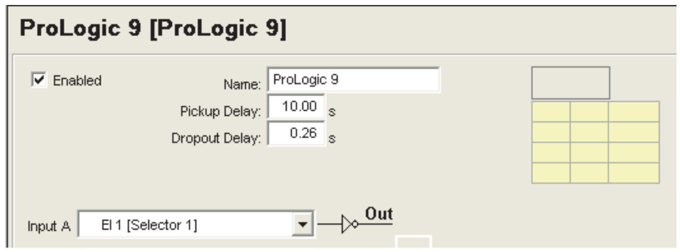


Figure L.7: ProLogic 9

ProLogic 10 has no intentional delay and becomes high for the combined dropout time of ProLogic 9 and 10 equalling 0.52 seconds.

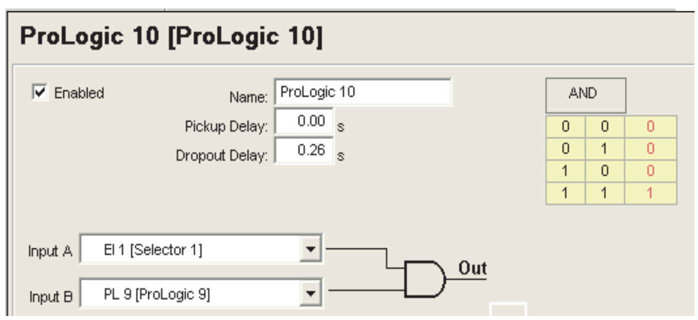


Figure L.8: ProLogic 10

Group Logic 1 is used to switch to the new setting group; there is no intentional delay. You can also provide four additional logic inputs to be used to provide qualifiers before switching setting groups. The example uses a ProLogic statement and an external input as qualifiers, see example "Using ProLogic to Qualify Group Logic Statements" on page Appendix L-13.

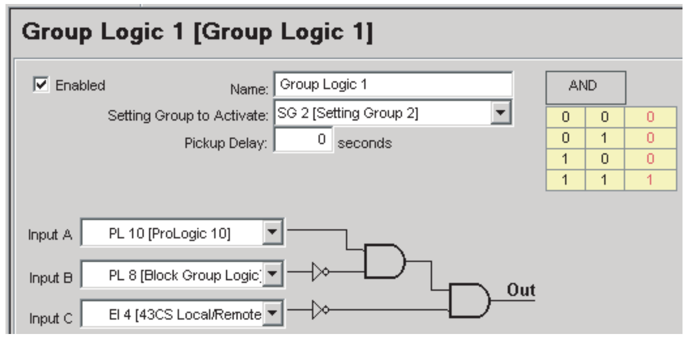


Figure L.9: Group Logic 1

Setting Group 2 – Logic Statements

When setting group two becomes active either through a setting group change or is the default group after relay power up, ProLogic 9 becomes high after the 10.00 second delay, if external input one is low. The example shows ProLogic 9 set for a 0.26 second dropout time to be used with ProLogic 10 dropout timer allowing for the slower processing thread where Group Logic is processed and providing a definite timed pulse to the group logic.

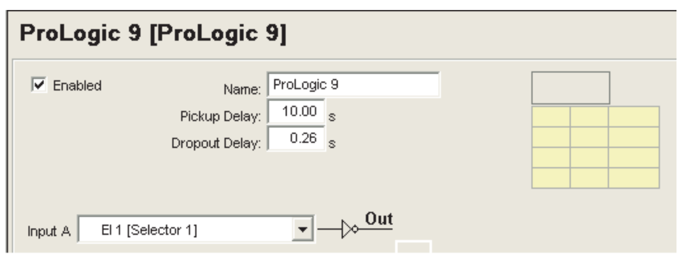


Figure L.10: ProLogic 9

ProLogic 10 has no intentional delay and becomes high for the combined drop-out time of ProLogic 9 and 10 equalling 0.52 seconds.

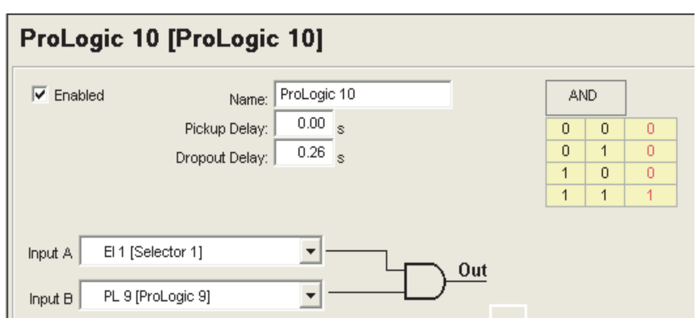


Figure L.11: ProLogic 10

Group Logic 1 is used to switch to the new setting group; there is no intentional delay.

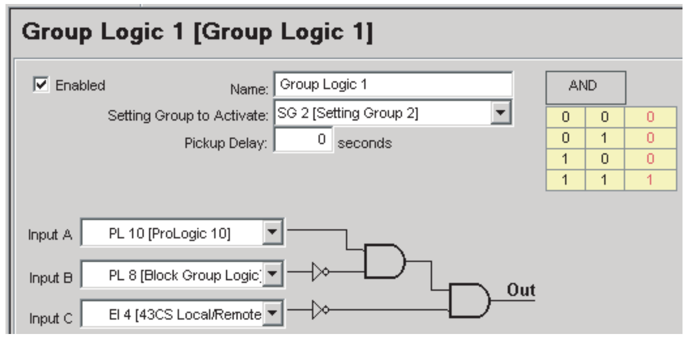


Figure L.12: Group Logic 1

Using Three External Inputs to Toggle Setting Group

Three external inputs connected to an eight position selector switch. The output contact is used to build a truth table to toggle between eight setting groups. In this example we connect EI 1, EI 2, and EI 3 to the selector switch output contacts.

Selector Switch	Input States			Setting Group to Activate
	EI 3	EI 2	EI 1	
1	0	0	0	Setting Group 1
2	0	0	1	Setting Group 2
3	0	1	0	Setting Group 3
4	0	1	1	Setting Group 4
5	1	0	0	Setting Group 5
6	1	0	1	Setting Group 6
7	1	1	0	Setting Group 7
8	1	1	1	Setting Group 8

Setting Group 1…8 – Logic Statements

The following Group Logic statements are entered into each of the eight setting groups.

When the selector switch is rotated to the appropriate position the corresponding setting group becomes active. Each setting group logic can have a specific time delay pickup setting. You can also provide two additional logic inputs in each statement to be used to provide qualifiers before switching setting groups. We are using a ProLogic statement and an external input as qualifiers. For details see "Using ProLogic to Qualify Group Logic Statements" on page Appendix L-13.

EI 1 low, EI 2 low, and EI 3 low

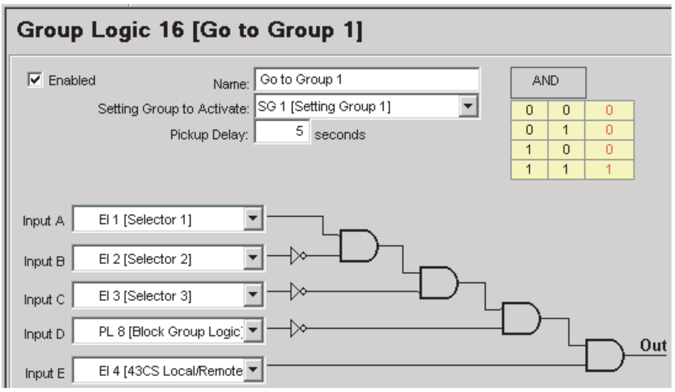


Figure L.13: Group Logic 16

EI 1 high, EI 2 low, and EI 3 low

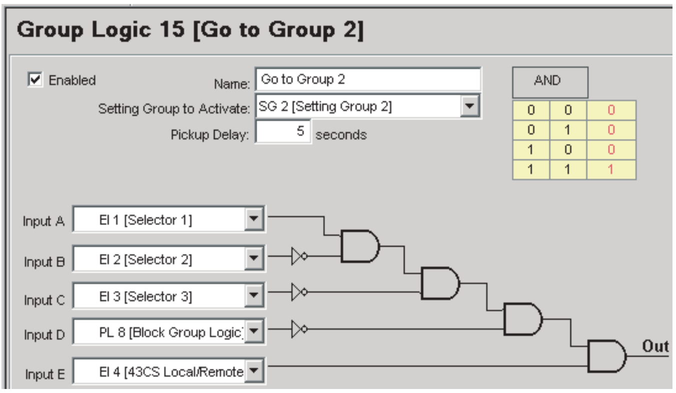


Figure L.14: Group Logic 15

EI 1 low, EI 2 high, and EI 3 low

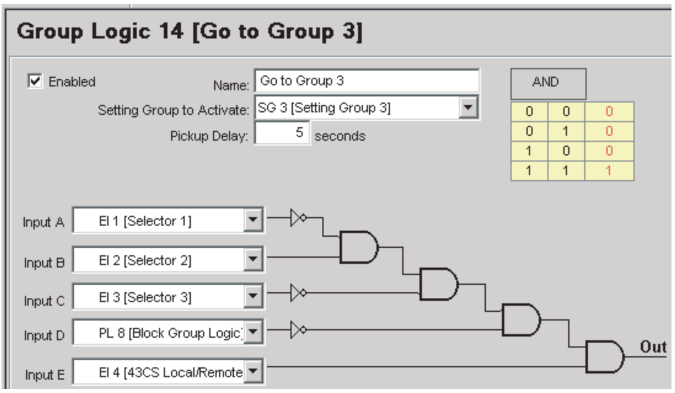


Figure L.15: Group Logic 14

EI 1 high, EI 2 high, and EI 3 low

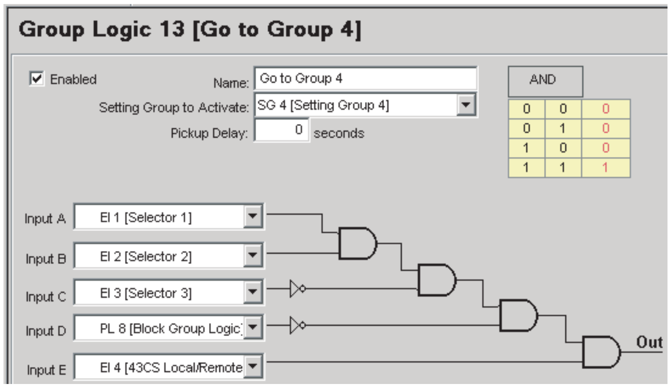


Figure L.16: Group Logic 13

EI 1 low, EI 2 low, and EI 3 high

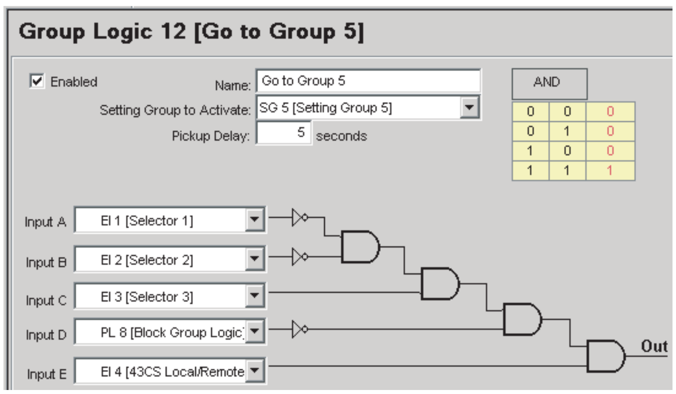


Figure L.17: Group Logic 12

EI 1 high, EI 2 low, and EI 3 high

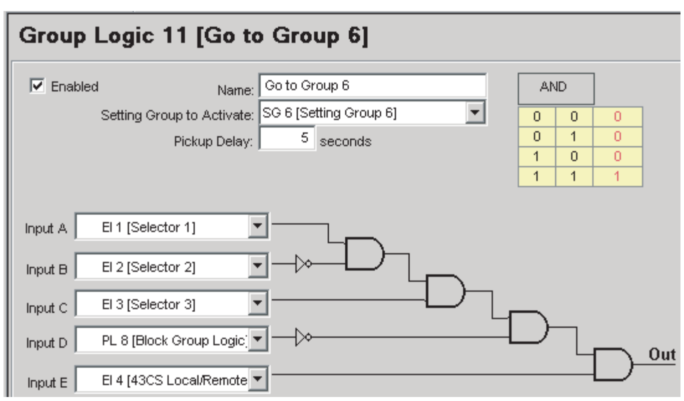


Figure L.18: Group Logic 11

EI 1 low, EI 2 high, and EI 3 high

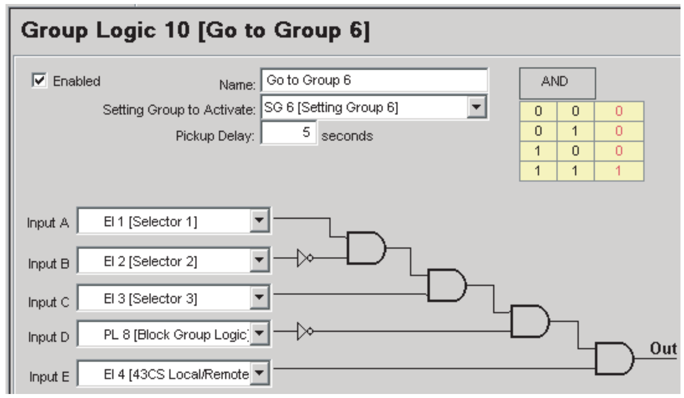


Figure L.19: Group Logic 10

EI 1 high, EI 2 high, and EI 3 high

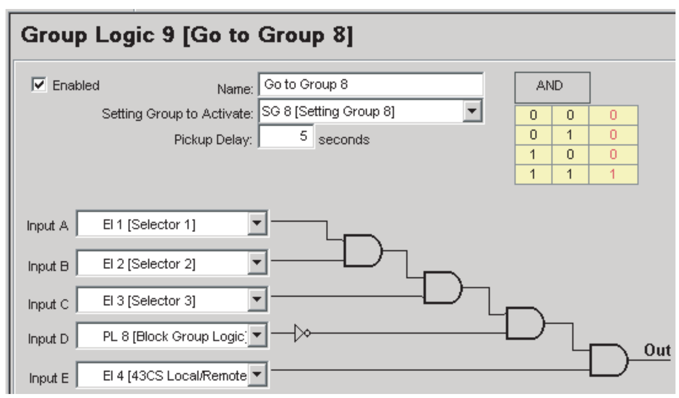


Figure L.20: Group Logic 9

Using ProLogic to Qualify Group Logic Statements

You can select from any available ProLogic inputs to make specific blocking logic to be used as a qualifier for any group logic decisions. In this example we use either the 50 or 50N elements to drive the Block Group Logic statement. There is no intentional pickup delay and 0.5 second drop-out delay to hold the block on after the block condition has reset

.

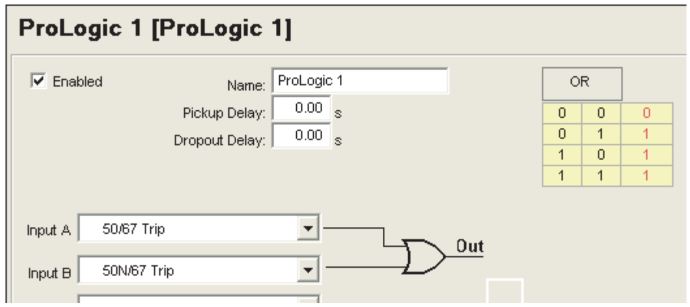


Figure L.21: ProLogic 1

Appendix M IEC 61850 Implementation

M.1 Protocol Implementation Conformance Statement (PICS)

Introduction

This specification is the Protocol Implementation Conformance Statement (PICS) and presents the ACSI conformance statements as defined in Annex A of Part 7-2 of the IEC 61850 standard specifications.

ACSI basic conformance statement

The basic conformance statement shall be as defined in Table M.1: Basic Conformance Statement.

Table M.1: Basic Conformance Statement			
		Server/Publisher	**Remarks**
Client -Server Roles			
B11	ServerSide (of two-party-application-association)	C1	Yes
B12	ServerSide (of two-party-application-association)		No
SCSMs Supported			
B21	SCSM:IEC 61850-8-1 used		YES
B22	SCSM:IEC 61850-8-1 used		No
B23	SCSM:IEC 61850-8-2 used		No
B24	SCSM		No
Generic Substation Event Model(GSE)			
B31	Publisherside	O	YES
B32	SubscriberSide		YES
Transmission of Sampled Value Model (SVC)			
B41	Publisherside	O	No
B42	SubscriberSide		No
c1 - Shall be ‘M’ if support for Logical-device model has been declared O - Optional M - Mandatory			

ACSI models conformance statement

The ASCI models conformance statement shall be as defined in Table M.2: ASCI Models Conformance Statement.

Table M.2: ASCI Models Conformance Statement

		Server/Publisher	Remarks
If Sever side (B11) supported			
M1	Logical Device	c2	YES
M2	Logical Node	c3	YES
M3	Data	c4	YES
M4	Data Set	c5	YES
M5	Substitution	O	YES
M6	Setting group control	O	NO
Reporting			
M7	Buffered report control		YES
M7-1	Sequence – number		YES
M7-2	Report-time-stamp		YES
M7-3	Reason-for-inclusion		YES
M7-4	Data-set-name		YES
M7-5	Data-reference		YES
M7-6	Buffer-overflow		YES
M7-7	Entry id		YES
M7-8	Buf Tm		YES
M7-9	IntgPd		YES
M7-10	GI		YES
M8	Unbuffered report control		YES
M8-1	Sequence – number		YES
M8-2	Report-time-stamp		YES
M8-3	Reason-for-inclusion		YES
M8-4	Data-set-name		YES
M8-5	Data-reference		YES
M8-6	IntgPd		YES
M8-7	GI	O	YES
	Logging	O	NO

Table M.2: ASCI Models Conformance Statement			
M9	Log control		O
M9-1	IntgPd		
M10	Log		
M11	Control		M
If GSE (B31/B32) is supported			
	M12-1	EntryID	

ACSI service conformance statement

The ASCI service conformance statement shall be as defined in Table M.3: ACSI service Conformance Statement.

Table M.3: ACSI service Conformance Statement				
	Services	AA: TP/MC	Server/ Publisher	Remarks
Server (Clause 6)				
S1	ServerDirectory	TP	M	YES

Table M.4: Application association (Clause 7)				
S2	Associate		M	YES
S3	Abort		M	YES
S4	Release		M	YES

Table M.5: Logical device (Clause 8)				
S5	Logical Device Directory	TP	M	YES

Table M.6: Logical Node (Clause 9)				
S6	LogicalNodeDirectory	TP	M	YES
S7	GetAllDataValues	TP	M	YES

Table M.7: Data (Clause 10)				
S8	GetDataValues	TP	M	YES
S9	SetDataValues	TP	O	YES
S10	GetDataDirectory	TP	M	YES
S11	GetDataDefinition	TP	M	YES

Table M.8: Data Set(Clause 11				
S12	GetDataSetValues	TP	M	YES
S13	SetDataSetValues	TP	O	NO
S14	CreateDataSet		TP	O
S15	DeleteDataSet		TP	O
S16	GetDataSetDirectory	TP	O	YES

Table M.9: Substitution (Clause 12)				
S17	SetDataValues	TP	M	YES

Table M.10: Setting group control (Clause 13)				
S18	SelectActive SG	TP	O	NO
S19	SelectEdit SG	TP	O	NO
S20	SetSGvalues	TP	O	NO

Table M.10: Setting group control (Clause 13)				
S21	ConfirmEditSGvalues	TP	O	NO
S22	GetSGvalues	TP	O	NO
S23	GetSGCBvalues	TP	O	NO

Table M.11: Reporting (Clause 14)				
Buffered report control block(BRCB)				
S24	Report	TP	c6	YES
S24-1	Data-change(dchg)			YES
S24-2	qchg-change(qchg)			NO
S24-3	Data-update(dupd)			NO
S25	GetBRCBValues	TP	c6	YES
S26	SetBRCBValues	TP	c6	YES
Unbuffered report control block(URCB)				
S27	Report	TP	c6	YES
S27-1	Data-change(dchg)			YES
S27-2	qchg-change(qchg)			NO
S27-3	Data-update(dupd)			NO
S28	GetURCBValues	TP	c6	YES
S29	SetURCBValues	TP	c6	YES
c6 – shall declare support for at least one(BRCB or URCB)				

Table M.12: Logging(clause 14)				
Log Control block				
S30	GetLCBValues	TP	M	NO
S31	SetLCBValues	TP	M	NO
Log				
S32	QueryLogByTime	TP	M	NO
S33	QueryLogAfter	TP	M	NO
S34	GetLogStatusValues	TP	M	NO
c7- shall declare support for at least one(query log by time or Query LogAfter)				

Table M.13: Generic Substation event model(GSE) (14.3.5.3.4)				
GOOSE – CONTROL - BLOCK				
S35	SendGOOSEMessage	MC	c8	YES
S36	GetGOReference	TP	c9	
S37	GetGOOSEElementNumber	TP	c9	
S38	GetGoCBValues	TP	O	YES
S39	SetGoCBValues	TP	O	YES
GSSE – CONTROL - BLOCK				
S40	SendGSSEMessage	MC	C8	NO
S41	GetGsReference	TP	C9	NO
S42	GetGSSEElementNumber	TP	C9	NO
S43	GetGsCBValues	TP	O	NO
S44	SetGsCBValues	TP	O	NO
c8- shall declare support for at least one(Send GOOSE Message or Send GSSE Message) c9- shall declare support if TP association is available				

Table M.14: Transmission of sampled value model(SVC) (Clause 16)				
Multicast SVC				
S45	SendMSVMessage	MC	C10	NO
S46	GetMSVCBValues	TP	O	NO
S47	SetMSVCBValues	TP	O	NO
Unicast SVC				
S48	SendUSVMessage	TP	C10	NO
S49	GetUSVCBValues	TP	O	NO
S50	SetUSVCBValues	TP	O	NO
C10- shall declare support for at least one(Send MSV Message or Send USV Message)				

Table M.15: control (17.5.1)				
S51	Select	TP	O	NO
S52	Select with value	TP	O	NO
S53	Cancel	TP	O	NO
S54	Operate	TP	M	NO
S55	Command-Termination	TP	O	NO
S56	Time Activated-Operate	TP	O	NO

M.2 Model Implementation Conformance Statement (MICS)

Introduction

This specification is the Model Implementation Conformance Statement (MICS) and presents the top-level IEC 61850 data model that has been implemented. The definitions of all used Logical Nodes and their associated Common Data Classes, components and associated enumerated values are also included for completeness.

The reader is expected to be conversant with the terminology presented within the IEC 61850 part 7 series of specifications.

Objective

To provide comprehensive details of the standard data object model elements supported by the device. The MICS is conformant to the devices associated ICD (Substation Configuration Language) file, according to part 6 of the IEC 61850 standards. The layout of the presented tables within this document is conformant to the part 7 series of the IEC 61850 standard specifications with the following exceptions:

- The “Trigger Options” field is not presented
- The “M/O” field is not present as the definitions are as deployed within the model
- An additional column “X” is used to signify custom attributes

Logical Device Definitions

This IEC 61850 server device contains one Logical Device. Logical Device contains a data model built from instances of specific Logical Nodes and must consist of at least an instance of the LPHD Logical Node (which is responsible for providing physical device information) and an instance of the LLN0 Logical Node (for addressing common issues across the Logical Device).

The IEC 61850 data model is contained within the Logical Devices detailed in the table below. All LNs are categorized according to the following table to en-

sure that data model variables in them have respective scope of data information.

Table M.16: Logical Devices	
Logical Device	**Comment / Usage**
Protection	Protection Domain
Measurements	Measurements Domain
System	System Domain
Records	Records Domain
VirtualElements	Virtual Elements Domain

IEC 61850 Logical Device Data Model

The IEC 61850 Logical Device top-level data model consists of instances of Logical Nodes. The data model name for a Logical Node instance is constructed from an optional prefix (known as the wrapper), the Logical Node name, and an instance ID (or suffix).

LD	LN Instance	LN Type	Description
Protection			
	D50LSPIOC1	PIOC1	
	D50LSPIOC2	PIOC1	
	D50LSPIOC3	PIOC1	
	D50LSPIOC4	PIOC1	
	D50PIOC5	PIOC2	
	D51PTOC1	PTOC1	
	D50NPIOC6	PIOC3	
	D51NPTOC2	PTOC2	
	D46_50PIOC7	PIOC3	
	D46_51PTOC3	PTOC2	
	D25RSYN1	RSYN1	
	D59PTOV1	PTOV1	
	D59PTOV2	PTOV1	
	D27PTUV1	PTUV1	

LD	LN Instance	LN Type	Description
	D27PTUV2	PTUV1	
	D81PTOF1	PTOF1	
	D81PTOF2	PTOF1	
	D81PTOF3	PTOF1	
	D81PTOF4	PTOF1	
	D81PTUF1	PTUF1	
	D81PTUF2	PTUF1	
	D81PTUF3	PTUF1	
	D81PTUF4	PTUF1	
	D81PFRC1	PFRC1	
	D81PFRC2	PFRC1	
	D81PFRC3	PFRC1	
	D81PFRC4	PFRC1	
	D32PDOP1	PDOP1	
	D32PDOP2	PDOP1	
	D50BFRBRF1	RBRF1	
	D50BFRBRF2	RBRF1	
	D50BFRBRF3	RBRF1	
	D50BFRBRF4	RBRF1	
	D79RREC1	RREC1	
	D79RREC2	RREC1	
	D50GPIOC8	PIOC4	
	D50GPIOC9	PIOC4	
	D51GPTOC4	PTOC2	
Measurements			
	LLN0	LLN0	
	LPHD1	LPHD1	
	MMXU1	MMXU	
	MMXU2	MMXU	
	MMXU3	MMXU	
	MHAI1	MHAI	
	MSTA1	MSTA	
	MSTA2	MSTA	

LD	LN Instance	LN Type	Description
System			
	LLN0	LLN0	
	LPHD1	LPHD1	
	EIGGIO1	GGIO1	
	OCGGIO2	GGIO1	
	PLGGIO3	GGIO1	
	ALMGGIO4	GGIO1	
	GLGGIO5	GGIO2	
Records			
	LLN0	LLN0	
	LPHD1	LPHD1	
	RecordRDRE1	RDRE1	
Virtual Elements			
	LLN0	LLN0	
	LPHD1	LPHD1	
	VIStGGIO1	GGIO3	
	VIICGGIO2	GGIO3	
	VIOCGGIO3	GGIO3	

Logical Node Definitions

The definition tables for each of the Logical Nodes in the top-level data model are presented in the following sub-sections.

The following table presents a summary of the Logical Node templates used across the

Logical Devices within the overall IEC 61850-product data model:

LN Type	LN Class	Name Space
LLN0	LLN0	IEC61850–7–4: 2003
LPHD1	LPHD	IEC61850–7–4: 2003
D50LSPIOC1	PIOC	IEC61850–7–4: 2003
D50PIOC5	PIOC	IEC61850–7–4: 2003
D51PTOC1	PTOC	IEC61850–7–4: 2003

LN Type	LN Class	Name Space
D50NPIOC6	PIOC	IEC61850–7–4: 2003
D51NPTOC2	PTOC	IEC61850–7–4: 2003
D46_50PIOC7	PIOC	IEC61850–7–4: 2003
D46_51PTOC3	PTOC	IEC61850–7–4: 2003
D25RSYN1	RSYN	IEC61850–7–4: 2003
D59PTOV1	PTOV	IEC61850–7–4: 2003
D27PTUV1	PTUV	IEC61850–7–4: 2003
D81PTOF1	PTOF	IEC61850–7–4: 2003
D81PTUF1	PTUF	IEC61850–7–4: 2003
D81PFRC1	PFRC	IEC61850–7–4: 2003
D32PDOP1	PDOP	IEC61850–7–4: 2003
D50BFRBRF1	RBRF	IEC61850–7–4: 2003
D79RREC1	RREC	IEC61850–7–4: 2003
D50GPIOC8	PIOC	IEC61850–7–4: 2003
D51GPTOC4	PTOC	IEC61850–7–4: 2003
MMXU1	MMXU	IEC61850–7–4: 2003
MMXU2	MMXU	IEC61850–7–4: 2003
MMXU3	MMXU	IEC61850–7–4: 2003
MHAI1	MHAI	IEC61850–7–4: 2003
MSTA1	MSTA	IEC61850–7–4: 2003
MSTA2	MSTA	IEC61850–7–4: 2003
EIGGIO1	GGIO	IEC61850–7–4: 2003
OCGGIO2	GGIO	IEC61850–7–4: 2003
PLGGIO3	GGIO	IEC61850–7–4: 2003
ALMGGIO4	GGIO	IEC61850–7–4: 2003
GLGGIO5	GGIO	IEC61850–7–4: 2003
VIStGGIO1	GGIO	IEC61850–7–4: 2003
VIICGGIO2	GGIO	IEC61850–7–4: 2003
VIOCGGIO3	GGIO	IEC61850–7–4: 2003

Logical Node: LPHD1

Description: Physical Device Information

LN Class: LPHD

Attribute	Attr. Type	Explanation	T	X
PhyNam	DPL_1_PhyNam	Device Physical Name Plate		
PhyHealth	INS_1_PhyHealth	Physical Device Health		
Proxy	SPS_1_Proxy	Indicates if this device is proxy		

Logical Node: LLN0

Description: Logical Node 0

LN Class: LLN0

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_1_NamPlt	Name Plate		

Logical Node: MMXU1

Description: Measurements

LN Class: MMXU

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
TotW	MV_1_TotW	Total Active Power (Total P)		
TotVAR	MV_1_TotW	Total Reactive Power (Total Q		
HZ	MV_1_TotW	Frequency		
PhV	WYE_1_A	Main Phase to Ground Voltage		
A	WYE_1_A	Input 1 Phase Currents		

Logical Node: MMXU2

Description: Measurements

LN Class: MMXU

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
A	WYE_1_A	Input 2 Phase Currents		

Logical Node: MMXU3

Description: Measurements

LN Class: MMXU

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
PhV	WYE_1_A	Sync Voltage		
PhA	WYE_1_A	Ground current IG		

Logical Node: MSTA1

Description: Measurements

LN Class: MSTA

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Max VA	MV_1_MaxVA	3 phase Apparent power demand IN (MVA)		
Max W	MV_1_MaxVA	3 phase real power demand IN (MW)		
Max VAR	MV_1_MaxVA	3 phase reactive power demand IN (MVAR)		

Logical Node: MSTA2

Description: Measurements

LN Class: MSTA

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Max VA	MV_1_MaxVA	3 phase Apparent power demand OUT (MVA)		
Max W	MV_1_MaxVA	3 phase real power demand OUT (MW)		
Max VAR	MV_1_MaxVA	3 phase reactive power demand OUT (MVAR)		

Logical Node: MHAI1

Description: Measurements

LN Class: MHAI

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
HZ	MV_1_TotW	Frequency		
THD A	WYE_1_ThdA	THD Current		

Logical Node: RSYN1

Description: Protection

LN Class: RSYN

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Rel	SPS_1_Proxy			

Logical Node: PTUV1

Description: Protection

LN Class: PTUV

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_2_Str	Start		
OP	ACT_1_Op	Operated		

Logical Node: PDOP1

Description: Protection

LN Class: PDOP

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_2_Str	Start		
OP	ACT_1_Op	Operated		

Logical Node: PIOC1

Description: Protection

LN Class: PIOC

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
OP	ACT_1_Op	Operated		

Logical Node: PIOC2

Description: Protection

LN Class: PIOC

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_1_Str	Start		
OP	ACT_1_Op	Operated		

Logical Node: PIOC3

Description:Protection

LN Class: PIOC

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_2_Str	Start		
OP	ACT_2_Op	Operated		

Logical Node: PIOC4

Description: Protection

LN Class: PIOC

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
OP	ACT_2_Op	Operated		

Logical Node: PTOC1

Description: Protection

LN Class: PTOC

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_1_Str	Start		
OP	ACT_1_Op	Operated		

Logical Node: PTOC2

Description: Protection

LN Class: PTOC

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_2_Str	Start		
OP	ACT_2_Op	Operated		

Logical Node: RBRF1

Description: Protection

LN Class: RBRF

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
OPEX	ACT_2_Op	Operated		

Logical Node: PTOV1

Description: Protection

LN Class: PTOV

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_2_Str	Start		
OP	ACT_1_Op	Operated		

Logical Node: RREC1

Description: Protection

LN Class:RREC

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
OP	ACT_2_Op	Operated		
AutoRecST	INS_1_AutoRecSt			

Logical Node: PFRC1

Description:Protection

LN Class: PFRC

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_2_Str	Start		
OP	ACT_2_Op	Operated		

Logical Node: PTOF1

Description: Protection

LN Class: PTOF

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_2_Str	Start		
OP	ACT_2_Op	Operated		

Logical Node: PTUF1

Description: Protection

LN Class: PTUF

Attribute	Attr. Type	Explanation	T	X
Mod	INC_1_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL_2_NamPlt	Name Plate		
Str	ACD_2_Str	Start		
OP	ACT_2_Op	Operated		

Logical Node: GGIO1

Description:System

LN Class: GGIO

Attribute	Attr. Type	Explanation	T	X
Mod	INC_2_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL__NamPlt	Name Plate		
Ind1	SPS_1_Proxy			
Ind2	SPS_1_Proxy			
Ind3	SPS_1_Proxy			
Ind4	SPS_1_Proxy			
Ind5	SPS_1_Proxy			
Ind6	SPS_1_Proxy			
Ind7	SPS_1_Proxy			
Ind8	SPS_1_Proxy			
Ind9	SPS_1_Proxy			
Ind10	SPS_1_Proxy			
Ind11	SPS_1_Proxy			
Ind12	SPS_1_Proxy			

Ind13	SPS_1_Proxy			
Ind14	SPS_1_Proxy			
Ind15	SPS_1_Proxy			
Ind16	SPS_1_Proxy			
Ind17	SPS_1_Proxy			
Ind18	SPS_1_Proxy			
Ind19	SPS_1_Proxy			
Ind20	SPS_1_Proxy			
Ind21	SPS_1_Proxy			
Ind22	SPS_1_Proxy			
Ind23	SPS_1_Proxy			
Ind24	SPS_1_Proxy			
Ind25	SPS_1_Proxy			
Ind26	SPS_1_Proxy			
Ind27	SPS_1_Proxy			
Ind28	SPS_1_Proxy			
Ind29	SPS_1_Proxy			
Ind30	SPS_1_Proxy			
Ind31	SPS_1_Proxy			
Ind32	SPS_1_Proxy			
Ind33	SPS_1_Proxy			
Ind34	SPS_1_Proxy			
Ind35	SPS_1_Proxy			
Ind36	SPS_1_Proxy			
Ind37	SPS_1_Proxy			
Ind38	SPS_1_Proxy			
Ind39	SPS_1_Proxy			
Ind40	SPS_1_Proxy			
Ind41	SPS_1_Proxy			
Ind42	SPS_1_Proxy			
Ind43	SPS_1_Proxy			
Ind44	SPS_1_Proxy			
Ind45	SPS_1_Proxy			
Ind46	SPS_1_Proxy			
Ind47	SPS_1_Proxy			
Ind48	SPS_1_Proxy			

Ind49	SPS_1_Proxy			
Ind50	SPS_1_Proxy			
Ind51	SPS_1_Proxy			
Ind52	SPS_1_Proxy			
Ind53	SPS_1_Proxy			
Ind54	SPS_1_Proxy			
Ind55	SPS_1_Proxy			
Ind56	SPS_1_Proxy			
Ind57	SPS_1_Proxy			
Ind58	SPS_1_Proxy			
Ind59	SPS_1_Proxy			
Ind60	SPS_1_Proxy			
Ind61	SPS_1_Proxy			
Ind62	SPS_1_Proxy			
Ind63	SPS_1_Proxy			
Ind64	SPS_1_Proxy			

Logical Node: GGIO2

Description: System

LN Class: GGIO

Attribute	Attr. Type	Explanation	T	X
Mod	INC_2_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL__NamPlt	Name Plate		
IntIn	INS_1_IntIn1			
Ind1	SPS_1_Proxy			
Ind2	SPS_1_Proxy			
Ind3	SPS_1_Proxy			
Ind4	SPS_1_Proxy			
Ind5	SPS_1_Proxy			
Ind6	SPS_1_Proxy			

Ind7	SPS_1_Proxy			
Ind8	SPS_1_Proxy			
Ind9	SPS_1_Proxy			
Ind10	SPS_1_Proxy			
Ind11	SPS_1_Proxy			
Ind12	SPS_1_Proxy			
Ind13	SPS_1_Proxy			
Ind14	SPS_1_Proxy			
Ind15	SPS_1_Proxy			
Ind16	SPS_1_Proxy			
Ind17	SPS_1_Proxy			
Ind18	SPS_1_Proxy			
Ind19	SPS_1_Proxy			
Ind20	SPS_1_Proxy			
Ind21	SPS_1_Proxy			
Ind22	SPS_1_Proxy			
Ind23	SPS_1_Proxy			
Ind24	SPS_1_Proxy			
Ind25	SPS_1_Proxy			
Ind26	SPS_1_Proxy			
Ind27	SPS_1_Proxy			
Ind28	SPS_1_Proxy			
Ind29	SPS_1_Proxy			
Ind30	SPS_1_Proxy			
Ind31	SPS_1_Proxy			
Ind32	SPS_1_Proxy			
Ind33	SPS_1_Proxy			
Ind34	SPS_1_Proxy			
Ind35	SPS_1_Proxy			
Ind36	SPS_1_Proxy			
Ind37	SPS_1_Proxy			
Ind38	SPS_1_Proxy			
Ind39	SPS_1_Proxy			
Ind40	SPS_1_Proxy			
Ind41	SPS_1_Proxy			
Ind42	SPS_1_Proxy			

Ind43	SPS_1_Proxy			
Ind44	SPS_1_Proxy			
Ind45	SPS_1_Proxy			
Ind46	SPS_1_Proxy			
Ind47	SPS_1_Proxy			
Ind48	SPS_1_Proxy			
Ind49	SPS_1_Proxy			
Ind50	SPS_1_Proxy			
Ind51	SPS_1_Proxy			
Ind52	SPS_1_Proxy			
Ind53	SPS_1_Proxy			
Ind54	SPS_1_Proxy			
Ind55	SPS_1_Proxy			
Ind56	SPS_1_Proxy			
Ind57	SPS_1_Proxy			
Ind58	SPS_1_Proxy			
Ind59	SPS_1_Proxy			
Ind60	SPS_1_Proxy			
Ind61	SPS_1_Proxy			
Ind62	SPS_1_Proxy			
Ind63	SPS_1_Proxy			
Ind64	SPS_1_Proxy			

Logical Node: GGIO3

Description: Virtual Elements

LN Class: GGIO

Attribute	Attr. Type	Explanation	T	X
Mod	INC_2_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL__NamPlt	Name Plate		
Ind1	SPS_1_Proxy			
Ind2	SPS_1_Proxy			

Ind3	SPS_1_Proxy			
Ind4	SPS_1_Proxy			
Ind5	SPS_1_Proxy			
Ind6	SPS_1_Proxy			
Ind7	SPS_1_Proxy			
Ind8	SPS_1_Proxy			
Ind9	SPS_1_Proxy			
Ind10	SPS_1_Proxy			
Ind11	SPS_1_Proxy			
Ind12	SPS_1_Proxy			
Ind13	SPS_1_Proxy			
Ind14	SPS_1_Proxy			
Ind15	SPS_1_Proxy			
Ind16	SPS_1_Proxy			
Ind17	SPS_1_Proxy			
Ind18	SPS_1_Proxy			
Ind19	SPS_1_Proxy			
Ind20	SPS_1_Proxy			
Ind21	SPS_1_Proxy			
Ind22	SPS_1_Proxy			
Ind23	SPS_1_Proxy			
Ind24	SPS_1_Proxy			
Ind25	SPS_1_Proxy			
Ind26	SPS_1_Proxy			
Ind27	SPS_1_Proxy			
Ind28	SPS_1_Proxy			
Ind29	SPS_1_Proxy			
Ind30	SPS_1_Proxy			

Logical Node: RDRE1

Description: Record

LN Class: RDRE

Attribute	Attr. Type	Explanation	T	X
Mod	INC_2_Mod	Mode		
Beh	INS_1_Beh	Behaviour		
Health	INS_1_Health	Health		
Namplt	LPL__NamPlt	Name Plate		
RcdTrg	SPC_1_RcdTrg			
RcdMade	SPS_1_Proxy			
FltNum	INS_1_IntIn1			
RcdStr	SPS_1_Proxy			

Common Data Class Definitions

The definition tables for each of the Common Data Classes used in the Logical Node definitions are presented in the following sub-sections.

From an application point-of-view the data attributes of a Common Data Class are classified according to their specific use. The characterization of data attributes, and the services that they support/provide, will be through the use of 'Functional Constraints'. The Functional Constraints are specified by the table below:

FC Name	Semantic	Source Definition
MX	Measurands (Analogue Values)	IEC 61850 – 7 - 2
ST	Status information	IEC 61850 – 7 - 2
CO	Control	IEC 61850 – 7 - 2
CF	Configuration	IEC 61850 – 7 - 2
DC	Description	IEC 61850 – 7 - 2
BR	Buffered Reports	IEC 61850 – 7 - 2
EX	Extended Definition	IEC 61850 – 7 - 2
GO	GOOSE Control	IEC 61850 – 7 - 2
RP	Buffered Reports	IEC 61850 – 7 - 2

Common Data Class: DPL_1_PhyNam

Description: Standard Device Name Plate

CDC Class: DPL

Attribute	Type	FC	Enumeration	Comment	X
Vendor	VisString255	DC			
hwRev	VisString255	DC			
swRev	VisString255	DC			
serNum	VisString255	DC			
Model	VisString255	DC			

Common Data Class: INS_1_PhyHealth

Description:

CDC Class: INS

Attribute	Type	FC	Enumeration	Comment	X
stVal	Enum	ST	PhyHealth		
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: SPS_1_Proxy

Description:

CDC Class: SPS

Attribute	Type	FC	Enumeration	Comment	X
stVal	Boolean	ST			
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: INC_1_Mod

Description:

CDC Class: INC

Attribute	Type	FC	Enumeration	Comment	X
stVal	Enum	ST	Mod		
q	Quality	ST			
t	Timestamp	ST			
ctlModel	Enum	CF	cltModel		

Common Data Class: INS_1_Beh

Description:

CDC Class: INS

Attribute	Type	FC	Enumeration	Comment	X
stVal	Enum	ST	Beh		
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: INS_1_Health

Description:

CDC Class: INS

Attribute	Type	FC	Enumeration	Comment	X
stVal	Health	ST	Health		
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: LPL_1_NamPlt

Description:

CDC Class: LPL

Attribute	Type	FC	Enumeration	Comment	X
Vendor	VisString255	DC			
swRev	VisString255	DC			
d	VisString255	DC			
configRev	VisString255	DC			
ldNs	VisString255	EX			

Common Data Class: LPL_2_NamPlt

Description:

CDC Class: LPL

Attribute	Type	FC	Enumeration	Comment	X
Vendor	VisString255	DC			
swRev	VisString255	DC			
d	VisString255	DC			

Common Data Class: MV_1_TotW

Description:

CDC Class: MV

Attribute	Type	FC	Enumeration	Comment	X
mag	AnalogueValue_1	MX			
Q	Quality	MX			
T	TimeStamp	MX			

Common Data Class: MV_1_MaxVA

Description:

CDC Class: MV

Attribute	Type	FC	Enumeration	Comment	X
mag	AnalogueValue_1	MX			
Q	Quality	MX			
T	TimeStamp	MX			

Common Data Class: WYE_1_A

Description:

CDC Class: WYE

Attribute	Type	FC	Enumeration	Comment	X
PhsA	CMV_1_phsA				
PhsB	CMV_1_phsA				
PhsC	CMV_1_phsA				

Common Data Class: CMV_1_phsA

Description:

CDC Class: CMV

Attribute	Type	FC	Enumeration	Comment	X
cVal	Struct	MX			
q	Quality	MX			
t	Timestamp	MX			

Common Data Class: WYE_1_THDA

Description:

CDC Class: WYE

Attribute	Type	FC	Enumeration	Comment	X
PhsA	CMV_2_phsA				
PhsB	CMV_2_phsA				
PhsC	CMV_2_phsA				

Common Data Class: ACD_1_Str

Description:

CDC Class: ACD

Attribute	Type	FC	Enumeration	Comment	X
general	Boolean	ST			
Dirgeneral	Enum	ST	dir		
PhsA	Boolean	ST			
DirPhsA	Enum	ST	dirph		
PhsB	Boolean	ST			
DirPhsB	Enum	ST	dirph		
PhsC	Boolean	ST			
DirPhsC	Enum	ST	dirph		
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: ACD_2_Str

Description:

CDC Class: ACD

Attribute	Type	FC	Enumeration	Comment	X
general	Boolean	ST			
Dirgeneral	Enum	ST	dir		
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: ACT_1_OP

Description:

CDC Class: ACT

Attribute	Type	FC	Enumeration	Comment	X
general	Boolean	ST			
PhsA	Boolean	ST			
PhsB	Boolean	ST			
PhsC	Boolean	ST			
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: ACT_2_OP

Description:

CDC Class: ACT

Attribute	Type	FC	Enumeration	Comment	X
general	Boolean	ST			
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: INS_1_Autoreset

Description:

CDC Class: INS

Attribute	Type	FC	Enumeration	Comment	X
stVal	Enum	ST	AutoRest		
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: INS_1_IntIn1

Description:

CDC Class: INS

Attribute	Type	FC	Enumeration	Comment	X
stVal	INT32	ST			
q	Quality	ST			
t	Timestamp	ST			

Common Data Class: SPC_1_RcdTrg

Description:

CDC Class: SPC

Attribute	Type	FC	Enumeration	Comment	X
stVal	Boolean	ST			
q	Quality	ST			
t	Timestamp	ST			
ctlModel	Enum	CF	ctlModel		

Common Data Class: SEQ_1_SeqA

Description:

CDC Class: SEQ

Attribute	Type	FC	Enumeration	Comment	X
c1	CMV_1_phsA				
c2	CMV_1_phsA				
c3	CMV_1_phsA				
seqT	Enum	MX	seqT		

Common Data Attribute Type definitions

Common data attribute types, known herein as components, are defined for use in the Common Data Classes defined in the sections above.

Component: Vector_1

Comment: Complex Vector (w.r.t. Floating Point Magnitude and Angle values) Parent Type: Vecto

Attribute	Type	Enumeration	Comment	X
Mag	AnalogueValue_1		The magnitude of the complex value	
Ang	AnalogueValue_1		The angle of the complex value	

Component: AnalogueValue_1

Comment: General Analogue Value (w.r.t. Floating Point Value)

Parent Type: AnalogueValue

Attribute	Type	Enumeration	Comment	X
F	Float32		Floating point value	

Component: Originator

Comment: Originator Value

Parent Type: Originator

Attribute	Type	Enumeration	Comment	X
orCat	Enum			
orIDent	Octet64			

Component: SPCOperate_1

Comment:

Attribute	Type	Enumeration	Comment	X
ctlVal	BOOLEAN			
Origin	Originator			
CtlNum	INT8U			
T	Timestamp			
Test	BOOLEAN			
Check	Dbpos			

Enumerated Type Definitions

The following sub-sections specify the enumerations that are associated to some Common Data Class attributes. The definition of the enumerations is according to IEC 61850-7-3 and IEC 61850-7-4 unless otherwise stated.

Enumerated type: AutoRecSt

Description: Auto-Reclose Status

Ordinal	Semantic
1	Ready
2	In Progress
3	Successful
4	Waiting for trip
5	Trip issued by protection
6	Fault disappeared
7	Wait to complete
8	Circuit breaker closed
9	Cycle unsuccessful
10	Unsuccessful
11	Aborted

Enumerated type: Beh
Description: Behaviour

Ordinal	Semantic
1	on
2	Blocked
3	Test
4	Test blocked
5	Off

Enumerated type: Health
Description: Health

Ordinal	Semantic
1	OK
2	Warning
3	Alarm

Enumerated type: Mod
Description: Mode

Ordinal	Semantic
1	on
2	Blocked
3	Test
4	Test blocked
5	Off

Enumerated type: PhyHealth
Description: PhyHealth

Ordinal	Semantic
1	OK
2	Warning
3	Alarm

Enumerated type: ctlModel
Description: Control Model

Ordinal	Semantic
0	status-only
1	direct-with-normal-security
2	sbo-with-normal-security
3	direct-with-enhanced-security
4	sbo-with-enhanced-security

Enumerated type: dirGeneral
Description: Direction

Ordinal	Semantic
0	Unknown
1	Forward
2	Bachward
3	Both

Enumerated type: dirPhs
Description: Direction

Ordinal	Semantic
0	Unknown
1	Forward
2	Backward

Enumerated type: orCat
Description: Originator Category

Ordinal	Semantic
0	not-supported
1	bay-control
2	station-control
3	remote-control
4	automatic-bay
5	automatic-station
6	automatic-remote
7	maintenance
8	process

Enumerated type: seqT
Description: Sequance Measurment

Ordinal	Semantic
0	pos_neg_zero
1	dir_quad_zero

M.3 Data Mapping Specifications

F-PRO Logical Device F-PRO logical device identification

F-PRO 4000 has the following IEC 61850 logical devices defined in its ICD file:

- FPROFaultData
- FPROMeasurements
- FPROProtection
- FPRORecords
- FPROSystem
- FPROVirtualElements

F-PRO logical nodes

Table 1defines the list of logical nodes (LN) for the F-PRO logical devices.

> Note:
>
> System logical nodes (group L) are not shown here.

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments	Section
FPRO Measurements	MMXU1	Measurement	Metering Data	3 phase measurement Information for voltage Input and current channel 1	
FPRO Measurements	MMXU2	Measurement	Metering Data	3 phase measurement Information for voltage Input and current channel 2	
FPRO Measurements	MMXU3	Measurement	Metering Data	Sync voltage and measured Ground current	5.2.3
FPRO Measurements	MHAI1	Measurement	THD Data	Phase THD current	5.2.5
FPRO Measurements	MSTA1	Measurement	Demand Data	Demand	5.2.6
FPRO Measurements	MSTA2	Measurement	Demand Data	Demand	5.2.7

FPRO Protection	D50LSPI OC1	Instantaneous Overcurrent	50LS-1 Main	Low Set Overcurrent	5.2.8
FPRO Protection	D50LSPI OC2	Instantaneous Overcurrent	50LS-2 Main	Low Set Overcurrent	5.2.9
FPRO Protection	D50LSPI OC3	Instantaneous Overcurrent	50LS-1 Aux	Low Set Overcurrent	5.2.10
FPRO Protection	D50LSPI OC4	Instantaneous Overcurrent	50LS-2 Aux	Low Set Overcurrent	5.2.11
FPRO Protection	D50PIOC 5	Instantaneous Overcurrent	Dev 51	Phase Overcurrent	5.2.12
FPRO Protection	D51PTO C1	Time Overcurrent	Dev 50	Phase Overcurrent	5.2.13
FPRO Protection	D50NPIO C6	Instantaneous Overcurrent	Dev 50N	Neutral Overcurrent	5.2.14
FPRO Protection	D51NPT OC2	Time Overcurrent	Dev 51N	Neutral Overcurrent	5.2.15
FPRO Protection	D50LSPI OC1	Instantaneous Overcurrent	50LS-1 Main	Low Set Overcurrent	5.2.8
FPRO Protection	D50LSPI OC2	Instantaneous Overcurrent	50LS-2 Main	Low Set Overcurrent	5.2.9
FPRO Protection	D50LSPI OC3	Instantaneous Overcurrent	50LS-1 Aux	Low Set Overcurrent	5.2.10
FPRO Protection	D50LSPI OC4	Instantaneous Overcurrent	50LS-2 Aux	Low Set Overcurrent	5.2.11
FPRO Protection	D50PIOC 5	Instantaneous Overcurrent	Dev 51	Phase Overcurrent	5.2.12
FPRO Protection	D51PTO C1	time Overcurrent	Dev 50	Phase Overcurrent	5.2.13
FPRO Protection	D50NPIO C6	Instantaneous Overcurrent	Dev 50N	Neutral Overcurrent	5.2.14
FPRO Protection	D51NPT OC2	time Overcurrent	Dev 51N	Neutral Overcurrent	5.2.15
LD	LN Name	LN Description	F-PRO Protec-tion Function	Comments	Section
FPRO Protection	D46_50P IOC7	Instantaneous Overcurrent	Dev 46-50	Negative Sequence Overcurrent	5.2.16
FPRO Protection	D46_51P TOC3	time Overcurrent	Dev 46-51	Negative Sequence Overcurrent	5.2.17
FPRO Protection	D25RSY N1	Sync check	25 Sync check	Synchronous check Information	5.2.18
FPROProtection	D59PTO V1	Overvoltage	Dev 59-1	Overvoltage 1	5.2.19

FPROProtection	D59PTO V2	Overvoltage	Dev 59-2	Overvoltage 2	5.2.20
FPROProtection	D27PTU V1	Undervoltage	Dev 27-1	Undervoltage 1	5.2.21
FPROProtection	D27PTU V2	Undervoltage	Dev 27-2	Undervoltage 2	5.2.22
FPROProtection	D81PTO F1	Over/ Underfrequency	Dev 81-1	Over-frequency	5.2.23
FPROProtection	D81PTO F2	Over/ Underfrequency	Dev 81-2	Over-frequency	5.2.24
FPROProtection	D81PTO F3	Over/ Underfrequency	Dev 81-3	Over-frequency	5.2.25
FPROProtection	D81PTO F4	Over/ Underfrequency	Dev 81-4	Over-frequency	5.2.26
FPROProtection	D81PTU F1	Over/ Underfrequency	Dev 81-1	Under-frequency	5.2.27
FPROProtection	D81PTU F2	Over/ Underfrequency	Dev 81-2	Under-frequency	5.2.28
FPROProtection	D81PTU F3	Over/ Underfrequency	Dev 81-3	Under-frequency	5.2.29
FPROProtection	D81PTU F4	Over/ Underfrequency	Dev 81-4	Under-frequency	5.2.30
FPROProtection	D81PFR C1	Over/ Underfrequency	Dev 81-1	Rate of change of Frequency 1	5.2.31
FPROProtection	D81PFR C2	Over/ Underfrequency	Dev 81-2	Rate of change of Frequency 2	5.2.32
FPROProtection	D81PFR C3	Over/ Underfrequency	Dev 81-3	Rate of change of Frequency 4	5.2.33
FPROProtection	D81PFR C4	Over/ Underfrequency	Dev 81-4	Rate of change of Frequency 4	5.2.34
FPRO Protection	D50LSPI OC3	Instantaneous Overcurrent	50LS-1 Aux	Low Set Overcurrent	5.2.10
FPRO Protection	D50LSPI OC4	Instantaneous Overcurrent	50LS-2 Aux	Low Set Overcurrent	5.2.11
FPRO Protection	D50PIOC 5	Instantaneous Overcurrent	Dev 51	Phase Overcurrent	5.2.12
FPRO Protection	D51PTO C1	time Overcurrent	Dev 50	Phase Overcurrent	5.2.13
FPRO Protection	D50NPIO C6	Instantaneous Overcurrent	Dev 50N	Neutral Overcurrent	5.2.14
FPRO Protection	D51NPT OC2	time Overcurrent	Dev 51N	Neutral Overcurrent	5.2.15

LD	LN Name	LN Description	F-PRO Protection Function	Comments	Section
FPROProtection	D32PDOP1	Directional Power	Dev 32-P	Directional Active Over power	5.2.35
FPROProtection	D32PDOP2	Directional Power	Dev 32-Q	Directional Reactive Over power	5.2.36
FPROProtection	D50BFRBRF1	Breaker Failure	50BF-1 Main	Breaker Failure Main-1	5.2.37
FPROProtection	D50BFRBRF2	Breaker Failure	50BF-2 Main	Breaker Failure Main-2	5.2.38
FPROProtection	D50BFRBRF3	Breaker Failure	50BF-1 Aux	Breaker Failure Aux-1	5.2.39
FPROProtection	D50BFRBRF4	Breaker Failure	50BF-2 Aux	Breaker Failure Aux-2	5.2.40
FPROProtection	D79RREC1	Recloser	Dev 79-Main	Main Recloser	5.2.41
FPROProtection	D79RREC2	Recloser	Dev 79-Aux	Auxiliary Recloser	5.2.42
FPROProtection	D50GPIOC8	Instantaneous Overcurrent	Dev 50G-1	Measured Netrual O/C	5.2.43
FPROProtection	D50GPIOC9	Instantaneous Overcurrent	Dev 50G-2	Measured Netrual O/C	5.2.44
FPROProtection	D51GPTOC4	Instantaneous Overcurrent	Dev 51G	Measured Netrual O/C	5.2.45
FPROSystem	EIGGIO1	General Process I/O	External Input (1-64)	External Input (1-9) are Currently in use.	5.2.46
FPROSystem	OCGGIO2	General Process I/O	Output Contact(1-64)	Output Contact(1-14) are Currently in use	5.2.47
FPROSystem	PLGGIO3	General Process I/O	ProLogic(1-64)	Protection Logic status (1-10) are Currently in use	5.2.48
FPROSystem	ALMGGIO4	Alarms	Alarms(1-64)	Alarm status	5.2.49
FPROSystem	GLGGIO5	General Process I/O	Group Logic (1-64)	Group Logic status (1-16) are Currently in use	5.2.50
FPROVirtualElements	VIStGGIO1	General Process I/O	Virtual Inputs (1-30)	Virtual Inputs status (1-30) are Currently Supported	5.2.51
FPROVirtualElements	VIICGGIO2	General Process I/O	Virtual Inputs (1-30)	Virtual Inputs controls (1-30) are Currently Supported	5.2.52
FPROVirtualElements	VIOCGGIO3	General Process I/O	Virtual Inputs (1-30)	Virtual Inputs out going controls (1-30) are Currently not Supported	5.2.53

Logical node specifications

The following sections provide detailed information on the F-PRO logical nodes of the F-PRO logical devices as defined in the previous section.

MMXU1

This section defines logical node data for the logical node MMXU1 of the F-PRO Measurements logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
MMXU1.MX.Hz.mag.f	Frequency
MMXU1.MX.PhV.phsA.cVal.mag.f	Voltage Phase A
MMXU1.MX.PhV.phsA.cVal.ang.f	Voltage Phase A Angle
MMXU1.MX.PhV.phsB.cVal.mag.f	Voltage Phase B
MMXU1.MX.PhV.phsB.cVal.ang.f	Voltage Phase B Angle
MMXU1.MX.PhV.phsC.cVal.mag.f	Voltage Phase C
MMXU1.MX.PhV.phsC.cVal.ang.f	Voltage Phase C Angle
MMXU1.MX.A.phsA.cVal.mag.f	Input 1: Current Phase A
MMXU1.MX.A.phsA.cVal.ang.f	Input 1: Current Phase A Angle
MMXU1.MX.A.phsB.cVal.mag.f	Input 1: Current Phase B
MMXU1.MX.A.phsB.cVal.ang.f	Input 1: Current Phase B Angle
MMXU1.MX.A.phsC.cVal.mag.f	Input 1: Current Phase C
MMXU1.MX.A.phsC.cVal.ang.f	Input 1: Current Phase C Angle
MMXU1.MX.TotW.mag.f	Real Power
MMXU1.MX.TotVAr.mag.f	Reactive Power

MMXU2

This section defines logical node data for the logical node MMXU2 of the FPROMeasurements logical device

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F -PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
MMXU2.MX.A.phsA.cVal.mag.f	Input 2: Current Phase A
MMXU2.MX.A.phsA.cVal.ang.f	Input 2: Current Phase A Angle
MMXU2.MX.A.phsB.cVal.mag.f	Input 2: Current Phase B
MMXU2.MX.A.phsB.cVal.ang.f	Input 2: Current Phase B Angle
MMXU2.MX.A.phsC.cVal.mag.f	Input 2: Current Phase C
MMXU2.MX.A.phsC.cVal.ang.f	Input 2: Current Phase C Angle

MMXU3

This section defines logical node data for the logical node MMXU3 of the FPROMeasurements logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
MMXU3.MX.PhV.phsA.cVal.mag.f	Sync Voltage Magnitude
MMXU3.MX.PhV.phsA.cVal.ang.f	Sync Voltage Angle
MMXU3.MX.PhV.phsB.cVal.mag.f	
MMXU3.MX.PhV.phsB.cVal.ang.f	
MMXU3.MX.PhV.phsC.cVal.mag.f	

MMXU3.MX.PhV.phsC.cVal.ang.f	
MMXU3.MX.A.phsA.cVal.mag.f	Ground Current IG Magnitude
MMXU3.MX.A.phsA.cVal.ang.	Ground Current IG Angle
MMXU3.MX.A.phsB.cVal.mag.f	
MMXU3.MX.A.phsB.cVal.ang.f	
MMXU3.MX.A.phsC.cVal.mag.f	
MMXU3.MX.A.phsC.cVal.ang.f	

MHAI1

This section defines logical node data for the logical node MHAI1 of the FPROMeasurements logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
MHAI1.MX.ThdA.phaA.cVal.m ag.f	THD Phase A Current
MHAI1.MX.ThdA.phaB.cVal.mag.f	THD Phase B Current
MHAI1.MX.ThdA.phaC.cVal.mag.f	THD Phase C Current

MSTA1

This section defines logical node data for the logical node MSTA1 of the FPROMeasurements logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
MSTA1.MV.MaxW.instMag	3 Phase Real Power Demand(IN) MW
MSTA1.MV.MaxVAr.instMag	3 Phase Reactive Power Demand(IN) MVAR
MSTA1.MV.MaxVA.instMag	3 Phase Apparent Power Demand(IN) MVA

MSTA2

This section defines logical node data for the logical node MSTA2 of the FPROMeasurements logical device.

Note:

Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
MSTA2.MV.MaxW.instMag	3 Phase Real Power Demand(OUT) MW
MSTA2.MV.MaxVAr.instMag	3 Phase Reactive Power Demand(OUT) MVAR
MSTA2.MV.MaxVA.instMag	3 Phase Apparent Power Demand(OUT) MVA

D50LSPIOC1

This section defines logical node data for the logical node D50LSPIOC1 of the FPROProtection logical device.

Note:

Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D50LSPIOC1.ST.Op.general	Operate(50LS-1 Main Trip)
D50LSPIOC1.ST.Op.phsA	Operate(50LS-1 Main Trip)Phase A
D50LSPIOC1.ST.Op.phsB	Operate(50LS-1 Main Trip)Phase B
D50LSPIOC1.ST.Op.phsC	Operate(50LS-1 Main Trip)Phase C

D50LSPIOC2

This section defines logical node data for the logical node D50LSPIOC2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D50LSPIOC2.ST.Op.general	Operate(50LS-2 Main Trip)
D50LSPIOC2.ST.Op.phsA	Operate(50LS-2 Main Trip)Phase A
D50LSPIOC2.ST.Op.phsB	Operate(50LS-2 Main Trip)Phase B
D50LSPIOC2.ST.Op.phsC	Operate(50LS-2 Main Trip)Phase C

D50LSPIOC3

This section defines logical node data for the logical node D50LSPIOC3 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D50LSPIOC3.ST.Op.general	Operate(50LS-1 Aux Trip)
D50LSPIOC3.ST.Op.phsA	Operate(50LS-1 Aux Trip)Phase A
D50LSPIOC3.ST.Op.phsB	Operate(50LS-1 Aux Trip)Phase B
D50LSPIOC3.ST.Op.phsC	Operate(50LS-1 Aux Trip)Phase C

D50LSPIOC4

This section defines logical node data for the logical node D50LSPIOC4 of the FPROProtection logical device.

Note:

Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D50LSPIOC4.ST.Op.general	Operate(50LS-2 Aux Trip)
D50LSPIOC4.ST.Op.phsA	Operate(50LS-2 Aux Trip)Phase A
D50LSPIOC4.ST.Op.phsB	Operate(50LS-2 Aux Trip)Phase B
D50LSPIOC4.ST.Op.phsC	Operate(50LS-2 Aux Trip)Phase C

D50PIOC5

This section defines logical node data for the logical node D50PIOC5 of the FPROProtection logical device.

Note:

Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D50PIOC5.ST.Str.phsA	Start(50 Alarm) Phase A
D50PIOC5.ST.Str.phsB	Start(50 Alarm) Phase B
D50PIOC5.ST.Str.phsC	Start(50 Alarm) Phase C
D50PIOC5.ST.Op.general	Operate(50 Trip)
D50PIOC5.ST.Op.PhsA	Operate (50 Trip) Phase A
D50PIOC5.ST.Op.PhsB	Operate (50 Trip) Phase B
D50PIOC5.ST.Op.PhsC	Operate (50 Trip) Phase C

D51PTOC1

This section defines logical node data for the logical node D51PTOC1 of the FPROProtection logical device.

Note:

Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D51PTOC1.ST.Str.phsA	Start(51 Alarm) Phase A
D51PTOC1.ST.Str.phsB	Start(51 Alarm) Phase B
D51PTOC1.ST.Str.phsC	Start(51 Alarm) Phase C
D51PTOC1.ST.Op.general	Operate(51 Trip)
D51PTOC1.ST.Op.PhsA	Operate (51 Trip) Phase A
D51PTOC1.ST.Op.PhsB	Operate (51 Trip) Phase B
D51PTOC1.ST.Op.PhsC	Operate (51 Trip) Phase C

D50NPIOC6

This section defines logical node data for the logical node D50NPIOC6 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D50NPIOC6.ST.Str.general	Start(50 Alarm)
D50NPIOC6.ST.Str.dirGeneral	Start(50 Alarm)
D50NPIOC6.ST.OP.general	Operate (50N Trip)

D51NPTOC2

This section defines logical node data for the logical node D51NPTOC2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D51NPTOC2.ST.Str.general	Start(51 Alarm)
D51NPTOC2.ST.Str.dirGeneral	Start(51 Alarm)
D51NPTOC2.ST.OP.general	Operate (51N Trip)

D46_50PIOC7

This section defines logical node data for the logical node D46_50PIOC7 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D46_50PIOC7.ST.OP.general	Operate (46-50 Trip)

D46_51PTOC3

This section defines logical node data for the logical node D46_51PTOC3 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D46_51PTOC3.ST.Str.general	Start(46-51 Alarm)
D46_51PTOC3.ST.Str.dirGeneral	Start(46-50 Alarm)
D46_51PTOC3.ST.OP.general	Operate (46-50 Trip)

D25RSYN1

This section defines logical node data for the logical node D25RSYN1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D25RSYN1.ST.Rel.stVal	Release(252759 Sync Check:Armed)

D59PTOV1

This section defines logical node data for the logical node D59PTOV1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D59PTOV1.ST.Op.general	Operate(59-1 Trip)
D59PTOV1.ST.Op.PhsA	Operate (59-1 Trip) Phase A
D59PTOV1.ST.Op.PhsB	Operate (59-1 Trip) Phase B
D59PTOV1.ST.Op.PhsC	Operate (59-1 Trip) Phase C

D59PTOV2

This section defines logical node data for the logical node D59PTOV2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D59PTOV2.ST.Op.general	Operate(59-2 Trip)
D59PTOV2.ST.Op.PhsA	Operate (59-2 Trip) Phase A
D59PTOV2.ST.Op.PhsB	Operate (59-2 Trip) Phase B
D59PTOV2.ST.Op.PhsC	Operate (59-2 Trip) Phase C

D27PTUV1

This section defines logical node data for the logical node D27PTUV1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D27PTUV1.ST.Op.general	Operate(27-1 Trip)
D27PTUV1.ST.Op.PhsA	Operate (27-1 Trip) Phase A
D27PTUV1.ST.Op.PhsB	Operate (27-1 Trip) Phase B
D27PTUV1.ST.Op.PhsC	Operate (27-1 Trip) Phase C

D27PTUV2

This section defines logical node data for the logical node D27PTUV2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D27PTUV2.ST.Op.general	Operate(27-2 Trip)
D27PTUV2.ST.Op.PhsA	Operate (27-2 Trip) Phase A
D27PTUV2.ST.Op.PhsB	Operate (27-2 Trip) Phase B
D27PTUV2.ST.Op.PhsC	Operate (27-2 Trip) Phase C

D81PTOF1

This section defines logical node data for the logical node D81PTOF1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D81PTOF1.ST.OP.general	Operate (81-1 Over Frequency Trip)

D81PTOF2

This section defines logical node data for the logical node D81PTOF2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D81PTOF2.ST.OP.general	Operate (81-2 Over Frequency Trip)

D81PTOF3

This section defines logical node data for the logical node D81PTOF3 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D81PTOF3.ST.OP.general	Operate (81-3 Over Frequency Trip)

D81PTOF4

This section defines logical node data for the logical node D81PTOF4 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D81PTOF4.ST.OP.general	Operate (81-4 Over Frequency Trip)

D81PTUF1

This section defines logical node data for the logical node D81PTUF1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D81PTUF1.ST.OP.general	Operate (81-1 Undr Frequency Trip)

D81PTUF2

This section defines logical node data for the logical node D81PTUF2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D81PTUF2.ST.OP.general	Operate (81-2 Under Frequency Trip)

D81PTUF3

This section defines logical node data for the logical node D81PTUF3 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D81PTUF3.ST.OP.general	Operate (81-3 Under Frequency Trip)

D81PTUF4

This section defines logical node data for the logical node D81PTUF4 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D81PTUF4.ST.OP.general	Operate (81-4 Under Frequency Trip)

D81PFRC1

This section defines logical node data for the logical node D81PFRC1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D81PFRC1.ST.OP.general	Operate (81-1 Rate of Change of Frequency Trip)

D81PFRC2

This section defines logical node data for the logical node D81PFRC2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D81PFRC2.ST.OP.general	Operate (81-2 Rate of Change of Frequency Trip)

D81PFRC3

This section defines logical node data for the logical node D81PFRC3 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D81PFRC3.ST.OP.general	Operate (81-3 Rate of Change of Frequency Trip)

D81PFRC4

This section defines logical node data for the logical node D81PFRC4 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D81PFRC4.ST.OP.general	Operate (81-4 Rate of Change of Frequency Trip)

D32PDOP1

This section defines logical node data for the logical node D32PDOP1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D32PDOP1ST.Str.dirGeneral	Operate (32-Directional Power) Active
D32PDOP1.ST.OP.general	Operate (32-Directional Power) Active

D32PDOP2

This section defines logical node data for the logical node D32PDOP2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D32PDOP2ST.Str.dirGeneral	Operate (32-Directional Power) Reactive
D32PDOP2.ST.OP.general	Operate (32-Directional Power) Reactive

D50BFRBRF1

This section defines logical node data for the logical node D50BFRBRF1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D50BFRBRF1.ST.opex.general	Operate (50BF-1 Main Trip)

D50BFRBRF2

This section defines logical node data for the logical node D50BFRBRF2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D50BFRBRF2.ST.opex.general	Operate (50BF-2 Main Trip)

D50BFRBRF3

This section defines logical node data for the logical node D50BFRBRF3 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
D50BFRBRF3.ST.opex.general	Operate (50BF-1 Aux Trip)

D50BFRBRF4

This section defines logical node data for the logical node D50BFRBRF4 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D50BFRBRF4.ST.opex.general	Operate (50BF-2 Aux Trip)

D79RREC1

This section defines logical node data for the logical node D79RREC1of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D79RREC1.ST.OP.general	Operate (79 Recloser Main)

D79RREC2

This section defines logical node data for the logical node D79RREC2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D79RREC2.ST.OP.general	Operate (79 Recloser Aux)

D50GPIOC8

This section defines logical node data for the logical node D50GPIOC8 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D50GPIOC8.ST.Str.general	Start(50G-1 Alarm)
D50GPIOC8.ST.Str.dirGeneral	Start(50G-1 Alarm)
D50GPIOC8.ST.OP.general	Operate (50G-1 Trip)

D50GPIOC9

This section defines logical node data for the logical node D50GPIOC9 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D50GPIOC9.ST.Str.general	Start(50G-2 Alarm)
D50GPIOC9.ST.Str.dirGeneral	Start(50G-2 Alarm)
D50GPIOC9.ST.OP.general	Operate (50G-2 Trip)

D51GPTOC4

This section defines logical node data for the logical node D51GPTOC4 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
D51GPTOC4.ST.Str.general	Start(51G Alarm)
D51GPTOC4.ST.Str.dirGeneral	Start(51G Alarm)
D51GPTOC4.ST.OP.general	Operate (51G Trip)

EIGGIO1

This section defines logical node data for the logical node EIGGIO1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
EIGGIO1.ST.Ind1.stVal	General Indication (binary input) – External Input 1
EIGGIO1.ST.Ind2.stVal	General Indication (binary input) – External Input 2
EIGGIO1.ST.Ind3.stVal	General Indication (binary input) – External Input 3
EIGGIO1.ST.Ind4.stVal	General Indication (binary input) – External Input 4
EIGGIO1.ST.Ind5.stVal	General Indication (binary input) – External Input 5
EIGGIO1.ST.Ind6.stVal	General Indication (binary input) – External Input 6
EIGGIO1.ST.Ind7.stVal	General Indication (binary input) – External Input 7
EIGGIO1.ST.Ind8.stVal	General Indication (binary input) – External Input 8
EIGGIO1.ST.Ind9.stVal	General Indication (binary input) – External Input 9
EIGGIO1.ST.Ind10.stVal to EIGGIO1.ST.Ind64.stVal	General Indication (binary input) – Reserved (future use)

OCGGIO2

This section defines logical node data for the logical node OCGGIO2 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
OCGGIO2.ST.Ind1.stVal	General Indication (binary input) – Output Contact 1
OCGGIO2.ST.Ind2.stVal	General Indication (binary input) – Output Contact 2
OCGGIO2.ST.Ind3.stVal	General Indication (binary input) – Output Contact 3
OCGGIO2.ST.Ind4.stVal	General Indication (binary input) – Output Contact 4
OCGGIO2.ST.Ind5.stVal	General Indication (binary input) – Output Contact 5
OCGGIO2.ST.Ind6.stVal	General Indication (binary input) – Output Contact 6
OCGGIO2.ST.Ind7.stVal	General Indication (binary input) – Output Contact 7
OCGGIO2.ST.Ind8.stVal	General Indication (binary input) – Output Contact 8
OCGGIO2.ST.Ind9.stVal	General Indication (binary input) – Output Contact 9
OCGGIO2.ST.Ind10.stVal	General Indication (binary input) – Output Contact 10
OCGGIO2.ST.Ind11.stVal	General Indication (binary input) – Output Contact 11
OCGGIO2.ST.Ind12.stVal	General Indication (binary input) – Output Contact 12
OCGGIO2.ST.Ind13.stVal	General Indication (binary input) – Output Contact 13
OCGGIO2.ST.Ind14.stVal	General Indication (binary input) – Output Contact 14
OCGGIO2.ST.Ind11.stVal to OCGGIO2.ST.Ind64.stVal	General Indication (binary input) – Reserved (future use)

PLGGIO3

This section defines logical node data for the logical node PLGGIO3 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
PLGGIO3.ST.Ind1.stVal	General Indication (binary input) – ProLogic 1
PLGGIO3.ST.Ind2.stVal	General Indication (binary input) – ProLogic 2
PLGGIO3.ST.Ind3.stVal	General Indication (binary input) – ProLogic 3
PLGGIO3.ST.Ind4.stVal	General Indication (binary input) – ProLogic 4
PLGGIO3.ST.Ind5.stVal	General Indication (binary input) – ProLogic 5
PLGGIO3.ST.Ind6.stVal	General Indication (binary input) – ProLogic 6
PLGGIO3.ST.Ind7.stVal	General Indication (binary input) – ProLogic 7
PLGGIO3.ST.Ind8.stVal	General Indication (binary input) – ProLogic 8
PLGGIO3.ST.Ind9.stVal	General Indication (binary input) – ProLogic 9
PLGGIO3.ST.Ind10.stVal	General Indication (binary input) – ProLogic 10
PLGGIO3.ST.Ind11.stVal to PLGGIO3.ST.Ind64.stVal	General Indication (binary input) – Reserved (future use)

ALMGGIO4

This section defines logical node data for the logical node ALMGGIO4 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	**Description**
ALMGGIO4.ST.Ind1.stVal	General Indication (binary input) – Self Check Fail Alarm
ALMGGIO4.ST.Ind2.stVal	General Indication (binary input) – 60 LOP Alarm
ALMGGIO4.ST.Ind3.stVal	General Indication (binary input) – THD Alarm
ALMGGIO4.ST.Ind4.stVal	General Indication (binary input) – I*I*t Main Alarm
ALMGGIO4.ST.Ind5.stVal	General Indication (binary input) – I*I*t Aux Alarm
ALMGGIO4.ST.Ind6.stVal to ALMGGIO4.ST.Ind64.stVal	General Indication (binary input) – Reserved (future use)

GLGGIO5

This section defines logical node data for the logical node GLGGIO5 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
GLGGIO5.ST.Ind1.stVal	General Indication (binary input) – GoupLogic 1
GLGGIO5.ST.Ind2.stVal	General Indication (binary input) – GoupLogic 2
GLGGIO5.ST.Ind3.stVal	General Indication (binary input) – GoupLogic 3
GLGGIO5.ST.Ind4.stVal	General Indication (binary input) – GoupLogic 4
GLGGIO5.ST.Ind5.stVal	General Indication (binary input) – GoupLogic 5
GLGGIO5.ST.Ind6.stVal	General Indication (binary input) – GoupLogic 6
GLGGIO5.ST.Ind7.stVal	General Indication (binary input) – GoupLogic 7
GLGGIO5.ST.Ind8.stVal	General Indication (binary input) – GoupLogic 8
GLGGIO5.ST.Ind9.stVal	General Indication (binary input) – GoupLogic 9
GLGGIO5.ST.Ind10.stVal	General Indication (binary input) – GoupLogic 10
GLGGIO5.ST.Ind11.stVal	General Indication (binary input) – GoupLogic 11
GLGGIO5.ST.Ind125.stVal	General Indication (binary input) – GoupLogic 12
GLGGIO5.ST.Ind13.stVal	General Indication (binary input) – GoupLogic 13
GLGGIO5.ST.Ind14.stVal	General Indication (binary input) – GoupLogic 14
GLGGIO5.ST.Ind15.stVal	General Indication (binary input) – GoupLogic 15
GLGGIO5.ST.Ind16.stVal	General Indication (binary input) – GoupLogic 16
GLGGIO5.ST.Ind17.stVal to GLGGIO5.ST.Ind64.stVal	General Indication (binary input) – Reserved (future use)

VIStGGIO1

This section defines logical node data for the logical node VIStGGIO1 of the FPROProtection logical device.

> Note:
>
> Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
VIStGGIO1.ST.Ind1.stVal	General Indication (binary input) – Virtual Input 1
VIStGGIO1.ST.Ind2.stVal	General Indication (binary input) – Virtual Input 2
VIStGGIO1.ST.Ind3.stVal	General Indication (binary input) – Virtual Input 3
VIStGGIO1.ST.Ind4.stVal	General Indication (binary input) – Virtual Input 4
VIStGGIO1.ST.Ind5.stVal	General Indication (binary input) – Virtual Input 5
VIStGGIO1.ST.Ind6.stVal	General Indication (binary input) – Virtual Input 6
VIStGGIO1.ST.Ind7.stVal	General Indication (binary input) – Virtual Input 7
VIStGGIO1.ST.Ind8.stVal	General Indication (binary input) – Virtual Input 8
VIStGGIO1.ST.Ind9.stVal	General Indication (binary input) – Virtual Input 9
VIStGGIO1.ST.Ind10.stVal	General Indication (binary input) – Virtual Input 10
VIStGGIO1.ST.Ind11.stVal	General Indication (binary input) – Virtual Input 11
VIStGGIO1.ST.Ind12.stVal	General Indication (binary input) – Virtual Input 12
VIStGGIO1.ST.Ind13.stVal	General Indication (binary input) – Virtual Input 13
VIStGGIO1.ST.Ind14.stVal	General Indication (binary input) – Virtual Input 14
VIStGGIO1.ST.Ind15.stVal	General Indication (binary input) – Virtual Input 15
VIStGGIO1.ST.Ind16.stVal	General Indication (binary input) – Virtual Input 16
VIStGGIO1.ST.Ind17.stVal	General Indication (binary input) – Virtual Input 17
VIStGGIO1.ST.Ind18.stVal	General Indication (binary input) – Virtual Input 18
VIStGGIO1.ST.Ind19.stVal	General Indication (binary input) – Virtual Input 19
VIStGGIO1.ST.Ind20.stVal	General Indication (binary input) – Virtual Input 20
VIStGGIO1.ST.Ind21.stVal	General Indication (binary input) – Virtual Input 21
VIStGGIO1.ST.Ind22.stVal	General Indication (binary input) – Virtual Input 22
VIStGGIO1.ST.Ind23.stVal	General Indication (binary input) – Virtual Input 23
VIStGGIO1.ST.Ind24.stVal	General Indication (binary input) – Virtual Input 24

VIStGGIO1.ST.Ind25.stVal	General Indication (binary input) – Virtual Input 25
VIStGGIO1.ST.Ind26.stVal	General Indication (binary input) – Virtual Input 26
VIStGGIO1.ST.Ind27.stVal	General Indication (binary input) – Virtual Input 27
VIStGGIO1.ST.Ind28.stVal	General Indication (binary input) – Virtual Input 28
VIStGGIO1.ST.Ind29.stVal	General Indication (binary input) – Virtual Input 29
VIStGGIO1.ST.Ind30.stVal	General Indication (binary input) – Virtual Input 30
VIInCoGGIO2	
VIInCoGGIO3	

VIICGGIO2

This section defines logical node data for the logical node VIICGGIO2 of the FPROProtection logical device.

Note:

Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	**Description**
VIICGGIO2.ST.Ind1.stVal	General Indication (binary input) – Virtual Input 1
VIICGGIO2.ST.Ind2.stVal	General Indication (binary input) – Virtual Input 2
VIICGGIO2.ST.Ind3.stVal	General Indication (binary input) – Virtual Input 3
VIICGGIO2.ST.Ind4.stVal	General Indication (binary input) – Virtual Input 4
VIICGGIO2.ST.Ind5.stVal	General Indication (binary input) – Virtual Input 5
VIICGGIO2.ST.Ind6.stVal	General Indication (binary input) – Virtual Input 6
VIICGGIO2.ST.Ind7.stVal	General Indication (binary input) – Virtual Input 7
VIICGGIO2.ST.Ind8.stVal	General Indication (binary input) – Virtual Input 8
VIICGGIO2.ST.Ind9.stVal	General Indication (binary input) – Virtual Input 9
VIICGGIO2.ST.Ind10.stVal	General Indication (binary input) – Virtual Input 10
VIICGGIO2.ST.Ind11.stVal	General Indication (binary input) – Virtual Input 11
VIICGGIO2.ST.Ind12.stVal	General Indication (binary input) – Virtual Input 12
VIICGGIO2.ST.Ind13.stVal	General Indication (binary input) – Virtual Input 13
VIICGGIO2.ST.Ind14.stVal	General Indication (binary input) – Virtual Input 14

VIICGGIO2.ST.Ind15.stVal	General Indication (binary input) – Virtual Input 15
VIICGGIO2.ST.Ind16.stVal	General Indication (binary input) – Virtual Input 16
VIICGGIO2.ST.Ind17.stVal	General Indication (binary input) – Virtual Input 17
VIICGGIO2.ST.Ind18.stVal	General Indication (binary input) – Virtual Input 18
VIICGGIO2.ST.Ind19.stVal	General Indication (binary input) – Virtual Input 19
VIICGGIO2.ST.Ind20.stVal	General Indication (binary input) – Virtual Input 20
VIICGGIO2.ST.Ind21stVal	General Indication (binary input) – Virtual Input 21
VIICGGIO2.ST.Ind22.stVal	General Indication (binary input) – Virtual Input 22
VIICGGIO2.ST.Ind23.stVal	General Indication (binary input) – Virtual Input 23
VIICGGIO2.ST.Ind24.stVal	General Indication (binary input) – Virtual Input 24
VIICGGIO2.ST.Ind25.stVal	General Indication (binary input) – Virtual Input 25
VIICGGIO2.ST.Ind26.stVal	General Indication (binary input) – Virtual Input 26
VIICGGIO2.ST.Ind27.stVal	General Indication (binary input) – Virtual Input 27
VIICGGIO2.ST.Ind28.stVal	General Indication (binary input) – Virtual Input 28
VIICGGIO2.ST.Ind29.stVal	General Indication (binary input) – Virtual Input 29
VIICGGIO2.ST.Ind30.stVal	General Indication (binary input) – Virtual Input 30

VIOCGGIO3

This section defines logical node data for the logical node VIOCGGIO3 of the FPROProtection logical device.

Note:

Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

Data Name	Description
VIICGGIO3.ST.Ind1.stVal	General Indication (binary input) – Virtual Input 1
VIICGGIO3.ST.Ind2.stVal	General Indication (binary input) – Virtual Input 2
VIICGGIO3.ST.Ind3.stVal	General Indication (binary input) – Virtual Input 3
VIICGGIO3.ST.Ind4.stVal	General Indication (binary input) – Virtual Input 4
VIICGGIO3.ST.Ind5.stVal	General Indication (binary input) – Virtual Input 5
VIICGGIO3.ST.Ind6.stVal	General Indication (binary input) – Virtual Input 6

VIICGGIO3.ST.Ind7.stVal	General Indication (binary input) – Virtual Input 7
VIICGGIO3.ST.Ind8.stVal	General Indication (binary input) – Virtual Input 8
VIICGGIO3.ST.Ind9.stVal	General Indication (binary input) – Virtual Input 9
VIICGGIO3.ST.Ind10.stVal	General Indication (binary input) – Virtual Input 10
VIICGGIO3.ST.Ind11.stVal	General Indication (binary input) – Virtual Input 11
VIICGGIO3.ST.Ind12.stVal	General Indication (binary input) – Virtual Input 12
VIICGGIO3.ST.Ind13.stVal	General Indication (binary input) – Virtual Input 13
VIICGGIO3.ST.Ind14.stVal	General Indication (binary input) – Virtual Input 14
VIICGGIO3.ST.Ind15.stVal	General Indication (binary input) – Virtual Input 15
VIICGGIO3.ST.Ind16.stVal	General Indication (binary input) – Virtual Input 16
VIICGGIO3.ST.Ind17.stVal	General Indication (binary input) – Virtual Input 17
VIICGGIO3.ST.Ind18.stVal	General Indication (binary input) – Virtual Input 18
VIICGGIO3.ST.Ind19.stVal	General Indication (binary input) – Virtual Input 19
VIICGGIO3.ST.Ind20.stVal	General Indication (binary input) – Virtual Input 20
VIICGGIO3.ST.Ind21stVal	General Indication (binary input) – Virtual Input 21
VIICGGIO3.ST.Ind22.stVal	General Indication (binary input) – Virtual Input 22
VIICGGIO3.ST.Ind23.stVal	General Indication (binary input) – Virtual Input 23
VIICGGIO3.ST.Ind24.stVal	General Indication (binary input) – Virtual Input 24
VIICGGIO3.ST.Ind25.stVal	General Indication (binary input) – Virtual Input 25
VIICGGIO3.ST.Ind26.stVal	General Indication (binary input) – Virtual Input 26
VIICGGIO3.ST.Ind27.stVal	General Indication (binary input) – Virtual Input 27
VIICGGIO3.ST.Ind28.stVal	General Indication (binary input) – Virtual Input 28
VIICGGIO3.ST.Ind29.stVal	General Indication (binary input) – Virtual Input 29
VIICGGIO3.ST.Ind30.stVal	General Indication (binary input) – Virtual Input 30

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